THE Genuine Use and Effects OF THE GUNNE, AS WELL Experimentally as Mathematically DEMONSTRATED,

BY

ROBERT ANDERSON.

WITH

TABLES of PROJECTION, &c. Exactly Calculated and their Use Exemplified,

BY

THOMAS STREETE.

A New Work,

Of Singular Use unto Generals of Armies Enginiers and other Artists.

Tam Marte quam Mercurio.

LONDON

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MVSEVM
BRITAN
NICVM

To the High and Mighty Prince

JAMES

Duke of Monmouth & Buccluch, *Earl of* Doncaſter & Dalkeith, *Lord Scot of* Tindale Whitcheſter & Askdale, *Lord Great Chamberlain of* Scotland, *Lord Lieutenant of the Eaſt Riding of* York, *Governour of his Majeſties Town & Cittadel of* Kingſton *upon* Hull, *Chief Juſtice in Eyre of all his Majeſties Foreſts Chaces Parks & Warrens on the South ſide of* Trent, *Maſter of the Horſe to his Majeſty, one of the Lords of his Majeſties moſt honourable Privy Council, & Knight of the moſt Noble Order of the Garter.*

MY LORD,

I Am very well aſſured, that this Work (though one of the leaſt in bulk) will be of far greater uſe and advantage in War, than any or all other Books of this kind that have ever yet been extant; And

therefore to your Grace, by the joint consent of my friend Mr. *Robert Anderson*, are these New, Artificial, Experimented and desirable Demonstrations of his, and Careful Calculations of mine, most humbly Dedicated. It was in *September* 1672, that I first presented the same to your view; since which time, your Grace hath given sufficient testimony of your own personal Worth and Courage, whence for the future, we may well take it for a demonstrative verity, that you will be a right worthy Patron and Encourager of Armes and Arts: And his Highness *Prince Rupert* having prepared a way, by which all Gunnes and their Shot may be made fit for extraordinary service; there remaineth not any thing more than is herein contained, for the compleating of the practice of this Warlike and Mathematical Art, which is enough, even of it self, to baffle the very rudest of all open Opponents, and check the most subtile secret Detractors in their sinister designes;

Nor

Nor ever had my aforementioned friend or my ſelf, neither have we, any private ends herein reſerved to our ſelves. But not to trouble your Grace with more particulars; that which is principally intended in this Work and Dedication, is the Honour and defence of the King and his Dominions, with the benefit and ſafety of his Loyal Subjects, of which being one, I am alſo,

MY LORD,

A True Honourer of your

Illuſtrious Perſon & Worth;

THOMAS STREETE.

Ad Zoilum.

Zoilus fall on, with Poiſoned Envious jaw,
Like *Æſops* Viper, on this File to gnaw;
Wear out thy Teeth, thy Jawes in pieces tear:
We neither do thy Gall nor Poiſon fear.

TO THE

Courteous and Intelligent Reader.

HIſtories make manifeſt, that Victories were obtained and places defended, with greater Slaughter of Mankind in former Ages, than ſince the Invention of Gunnes; of the Uſe whereof, the chiefeſt improvers have been hitherto Diggs, Galileus, and Torricellius. Diggs in his Stratioticos, Pag. 349, and ſo forward, makes enquiry (1) about Pouder, (2) of the length of the Peece and the quantity of Pouder, (3) of the Pouder and the length of the Peece conſidered with the Bullet, (4) of Randons, what line it might be which the Bullet paſſeth in, whether the curve of an Ellipſis, or a Parabola, or Hyperbola: But in all theſe, he found little place for truth and real demonſtration; but gave opportunity to other enquirers. The famous Galileus in his 4th. Dialogue, Pag. 180, proves the flight of a Bullet to be in the curve line of a Parabola; and in Pag. 212, he gives a Table of the Horizontal Ranges. And Torricellius, Prop. 9. De motu Projectorum, Liber Secundus; and in Pag. 206. of the ſame Book, he brings the Horizontal Ranges to the Table of Sines; and the Greateſt Altitudes to the Verſed Sines: viz. That all Ranges upon the plain of the Horizon, are in proportion, as the Sines of the double of of the Elevation of their lines of Direction: as in the following Example, wherein and in Fig. 2. hereof, Let Z be at the Muzzel of the Peece, Z I the the line of Direction of the Chaſe of the Peece, Z F the Range of the Shot upon the plain of the Horizon, the Angle I Z G the Elevation of the Peece. Then, As the Sine of the double of the Angle I Z G, is to the Radius; So is Z F, to the Greateſt Randon, that is, the Range of the Shot upon the plain of the Horizon when the Peec is elevated 45 Degrees; and here note, that the Ranges upon the plain of the Horizon equidiſtant from 45 Degrees are equal, as is manifeſt by the Table of Horizontal Ranges. Alſo, G H the Greateſt Altitude of the Range, is as the half of the Verſed Sine of the double of the Elevation. And for the Duration of the Shot above the plain of

the

the Horizon, he proves that as the Radius, is to the Greatest Duration, which is when the Elevation is 90 Degrees; So is the Sine of any other Elevation of the Peece, to the Time of the Range of that Shot. Torricel. Lib. 2. Prop. 18. And on that subject, he hath many other excellent things. Yet these were still remaining, viz. 1. From any Shot of any Peece however made; to find the Greatest Randon; and to strike any place upon Ascents or Descents within the reach of the Peece. 2. The Complication and Relation of all Gunnes of the same kind amongst themselves; And hence, the Dimensions and the Requisit of Pouder of any Peece, with a Range answerable to any Degree being given; to find the Requisit of Pouder of any other Peece, and to strike any place at demand within its reach, its dimensions being also given. 3. The nature, property and use of Morter-Peeces, with their Complications and Relations. 4. Also the shooting of Granados out of long Gunnes, with their manifold uses, and many other things of consequence to this Art. But the number of propositions appertaining thereunto are without end; and therefore I have produced only 50 of the most Useful, whereas I might have added thousands; for considering the various turnings and complications of 12 quantities by squaring and cubing, &c. compared with the 17 and 18 Propositions of the 5. as also with the 23 of the 6 of Euclid, we may well affirm they are infinite. But before I break off, give me leave to speak a word or two, of them that assisted me, and to those that would haue frustrated these my endeavours. About three years since, I imparted my intentions to Mr. Thomas Streete; and that the 5th. Proposition hereof being troublesom, I intended to do it instrumentally, or to make brief Tables; but he offered the Calculation of the Tables as you shall find it truely performed, and the Tables very well ordered in their proper places; for which work, all practitioners in this Art are obliged to him. Another was helpful to me in many of my wearisom and chargeable Experiments; for which though I cannot retaliate, I shall always remember his kindness. But to those that magnify their own works being but toyes and trifles, and vilify that of others, of which they cannot do the like themselves, I say their envy is slighted, and the work here done,

VIZ.

THE

The Genuine Uſe and Effects OF THE GUNNE, AS WELL Experimentally as Mathematically DEMONSTRATED.

BY ROBERT ANDERSON.

Propoſition I.

A Peece lying parallel to the Horizon (Fig. 2.) *at H, whoſe height above the Horizon is GH, and laying its Shot at F; HG and GF being given, to find the Greateſt Randon.*

TO do this, We are to encreaſe or decreaſe the *Parabola* ſo, that H D ſhall be to D E, as 1 to 2. Then, in this caſe, half the Parameter is equal to D E, the Greateſt Randon. For H D : D E :: D E : Y. by the 11 *Prop:* of the firſt of *Apollonius*. Therefore $\frac{Y}{2}$ is equal to D E.

In Numbers, thus:

G F — 1331 — 3. 124178		Yards — 9423x6
Its Square — 6. 248356		
G H ſub. -94 — 1. 973128		5.653 8
Y — 18846 — 4. 275228		That is 5 miles
$\frac{Y}{2}$ — 9423.	The Greateſt Randon.	and 654 paces.

Propoſition II.

A Peece lying under level (Fig. 2.) *at Z, whoſe height above the Horizon is Z C, and laying its ſhot at B; Z C and C B, with the Angle C Z A being given, to find the Greateſt Randon.*

As the Radius, is to the Tangent of the Angle C Z A; ſo is Z C, to C A. Further, let Z C = A, A C = B, B C = C, Z G = Z. then B : A :: Z : G I in the Diagram; that is $\frac{AZ}{2B} = \frac{GI}{2}$ = GH in the Diagram. $\frac{2BZ^2}{AZ}$ = Y in the Diagram, by 11 *Prop.* 1 *Apoll.* then $\frac{AZ + 2BA}{2B}$ = D H in the Diagram. yet further Z + C = B D in the Diagram. $\frac{2BZ^2 + 4BCZ + 2BC^2}{AZ + 2BA}$ = Y in the Diagram, by 11 *Prop.* 1 *Apol.* Therefore $\frac{2BZ^2}{AZ} = \frac{2BZ^2 + 4BCZ + 2BC^2}{AZ + 2BA}$ it being Reduced is $C^2 = \frac{-2CZ}{+2BZ}$ that is, the Square of B C divided by A B, the Quotient is Z F. Laſtly, as the ſine of the double of the Angle I Z G, is to the Radius; ſo is Z F, to the Greateſt Randon.

The Radius.		10. 000000
The Tangent of the Angle C Z A.	84. 30	11. 016423
The height above the Horizon. Z C	94	1. 973128
A C.	976	2. 989551
C B.	701	2. 845718
Its Square		5. 691436
A B. 275. ſub.		2. 439333
Z F.	1787	3. 252103
The Radius.		10. 000000
The ſine of the double of	5. 30 ſub:	9. 280599
The Greateſt Randon.	9366	3. 971504

Prop.

Propoſition III.

A Peece lying above level (Fig. 2.) *at Z, whoſe height above the Horizon is C Z, and laying its ſhot at E; Z C and C E, with the Angle I Z G being given, to find the Greateſt Randon.*

Find C A as in the laſt; then as B C: C E:: A C: A E. For A B: B C:: B C: Z F. by Prop. 2. A B: B C:: B C + A B: Z F + B C. and B C: Z F + B C:: A B: B C + A B. Further, B C: Z F + B C:: A B + B C: A B + 2 B C + Z F, that is B C: C E:: A C: A E. then E C leſs C B is equal to Z F. Laſtly, as the ſine of the double of the Angle I Z G, is to the Radius; ſo is Z F, to the Greateſt Randon.

In the Triangle A Z C, Radius—	90°	10.000000
The Tangent of the Angle Z A C.—	89°	11.758079
The ſide Z C—	94	1.973128
The ſide A C.—	5385	3.731207
To which adde C E—	1517	3.180986
		6.912193
The ſum is— A E.—	6902 ſub:	3.838985
B C.—	1184	3.073208
C E — B C = Z F. —	333	2.522444
The Radius—		10.000000
The ſine of two degrees ſub:—		8.542819
The Greateſt Randon—	9542	3.979625

Propoſition IV.

A Peece lying above level (Fig. 2.) *at Z, its ſhot ſtriking the ſide of a Tower O; Z K and K O, with the Angle K Z R being given, to find the Greateſt Randon.*

As the Radius, to the Tangent of the Angle K Z R; ſo is Z K; to K R. and K R leſs K O, is O R; Then, as R O is to O K; ſo is Z K, to K F. by 5 *Prop. Archimedes Quad. Parab.* Laſtly, as the ſine of the double of the Angle R Z K, is to the Radius; ſo is Z F, to the greateſt Randon.

In the Triangle R Z K. Radius 90°		10. 000000
The Tangent of the Angle K Z R	8° 4′	9.151454
Z K	1184	3.073352
K R.	168	2.224806
K O.	94	
O R	74	1.869232
O K.	94	1.973128
Z K.	1184	3.073352
		5.046480
K F.	1504	3.177248
Z K + K F = Z F	2688	3.429429
The Radius		10. 000000
The ſine of 16° 8′ ſubſtract.		9.443847
The Greateſt Randon.	9673.	3.985582

Prop.

Propoſition V.

The Greateſt Randon, with the Baſe and Perpendicular, as (Fig. 2.) Z K *and* K O, *or* B C *and* C Z, *or* E C *and* C Z, *being given; to find* I Z G, *the Angle of the Elevation or Depreſſion of the Peece to ſtrike* E, O *and* B.

In all ſuch Parabola's, Z G is equal to the ſine, and G I equal to the verſed ſine of the double of the Angle I Z G.

So then, let G be equal to the Greateſt Randon, and $\frac{G}{2}$ be equal to C D in the firſt Diagram; A B in the firſt, equal to Z G in the ſecond; B D in the firſt, equal to G I in the ſecond.

Let Z K = B, K O = P, G I = V, Z G = A, or A = $\sqrt{GV - V^2}$, Then A — B = O Q, and $\frac{V - 2P}{2}$ = H Q in the Diagram; Further, $\frac{2A^2}{V} = Y$ and $\frac{2A^2 - 4AB + 2B^2}{V - 2P} = Y$; therefore $\frac{2A^2}{V} = \frac{2A^2 - 4AB + 2B^2}{V - 2P}$; that is, $2A^2V - 4A^2P = 2A^2V - 4ABV + 2B^2V$. therefore $\frac{4ABV - 2B^2V}{4P} = GV - V^2$, that is $4ABV - 2B^2V = 4GPV - 4PV^2$, that being divided by 2 V, it will be $2AB - B^2 = 2GP - 2PV$, that is, $\frac{B^2 + 2GP - 2PV}{2B} = \sqrt{GV - V^2}$. If $GP + \frac{B^2}{2} = R$, then $R^2 - 2RPV + P^2V^2 = B^2GV - B^2V^2$.

The

The Rule.

Supposing half the Greatest Randon, the Radius in the Table of Natural Sines, and reducing the given Base and Perpendicular to the same proportion;

Of the Greatest Randon in the Perpendicular, and half the square of the Base, the Sum for Ascents, but the Difference for Descents being squared; this last square divided by the sum of the squares of the Base and Perpendicular, we call the First Quotient.

Of the Greatest Randon in the Perpendicular, and half the square of the Base; the summe for Ascents, but the Difference for Descents, in the double of the Perpendicular, shall be one Product, and the square of the Base in the Greatest Randon, another Product: The sum of these two last found Products, except when the Greatest Randon in the Perpendicular hath been taken from the square of the Base, then the Difference of the said two Products, Divided by the sum of the squares of the Base and Perpendicular, we call the second Quotient.

From the square of half the second Quotient, take the first Quotient; then take the square Root of the remainer, Add it to, and substract it from that half Quotient; This last summe and Remainer, shall be the Versed Sines of the double of the Greater and lesser Elevation or of the Elevation and Depression of the Peece.

Example I.

Let there be given,		Reduced,
The Greatest Randon.	9673	20000
The Base---Z K.	1184	2448
The Perpendicular-KO.	94	194

The

The ſquare of the Baſe, is——5992704
The ſquare of the Perpendicular.——37636
The Common Diviſor.——6030340

The Greateſt Randon.——20000
The Perpendicular.——194
The Product.——3880000
Half the ſquare of the Baſe, Add——2996352
The ſum——6876352
Squared——47284216927904
The Diviſor——6030340
The Firſt Quotient——7841053

The ſum afore found——6876352
The double of the Perpendicular——388
The Product——2668024576
The ſquare of the Baſe——5992704
The Greateſt Randon——20000
The Product——119854080000
The ſum of the Products——122522104576
The Diviſor——6030340
The ſecond Quotient——20318

Half the ſecond Quotient——10159
The ſquare of this Half——10320,281
The Firſt Quotient, Subſtract——7841053
The Remainer——95364228
The ſquare Root of the Remainer——9765

° '
The Verſed ſine of——172——56——19924
The Verſed ſine of——16——8——394

The Greater Elevation——86——28
The leſſer Elevation——8——4

The

Example II.

	Given.	Reduced.
The Greateſt Randon.	9366	20000
The Baſe C B.	701	1497
The Perpendicular C Z.	94	201
The Square of the Baſe		2241009
The Square of the Perpendicular		40401
The Common Diviſor		2281410
The Greateſt Randon		20000
The Perpendicular		201
The Product		4020000
Half the Square of the Baſe		1120504
The Difference		2899496
Squared		8407077054016
The Diviſor		2281410
The firſt Quotient		3685036
The Difference aforefound		2899496
The Double of the Perpendicular		402
The Product		1165597392
The Square of the Baſe		2241009
The Greateſt Randon		20000
The Product		44820180000
The Sum of the Products		45985777392
The Diviſor		2281410
The ſecond Quotient		20157
Half the ſecond Quotient		10078
The Square of this Half		101566084
The Firſt Quotient, Subſtract.		3685036
The Remainer		97881048
The Square Root of the Remainer		9893

	o		
The Verſed ſine of	175	40	19971
The Verſed ſine of	11	2	185
The Elevation	87	50	
The Depreſſion	5	31	

Here note, when in Deſcents half the ſquare of the Baſe is leſs than the product of the Greateſt Randon in the Perpendicular, then (and not elſe) is the laſt found Angle the Depreſſion of the Peece: when the ſaid half ſquare and product are equal, the leſſer Elevation is o, and the Verſed Sine of the double of the greater, is the ſquare of the Baſe in the Greateſt Randon, divided by the ſum of the ſquares of the Baſe and Perpendicular.

Example III.

	Given.	Reduced.
The Greateſt Randon.	11233	20000
The Baſe C E.	12638	22501
The Perpendicular C Z.	1809	3221
The Square of the Baſe		506295001
The Square of the Perpendicular		10374841
The Common Diviſor		516669842
The Greareſt Randon		20000
The Perpendicular		3221
The Product		64420000
Half the Square of the Baſe		253147500
The Difference		188727500
Squared		35618069256250000
The Diviſor		516669842
The firſt Quotient		68937775

The Difference aforefound	188727500
The Double of the Perpendicular	6442
The Product	1215782555000
The Square of the Baſe	506295001
The Greateſt Randon	20000
The Product	10125900020000
The Difference of Products	8910117465000
The Diviſor	516669842
The ſecond Quotient	17245
Half the ſecond Quotient	8622½
The Square of this Half	74347506
The Firſt Quotient, Subſtract.	68937775
The Remainer	5409731
The Square Root of the Remainer	2326
	o ′
The Verſed ſine of — 95--26	10948
The Verſed Sine of — 68--16	6297
The Greater Elevation 47--43	
The Leſſer Elevation — 34---8	

Propoſition VI.

The Length of the Chaſe, Diameter of the bore, and Requiſit of Pouder of any Peece; with the Length of the Chaſe, and Diameter of the bore of any other Peece being given; To find its Requiſit of Pouder.

For if, (in *Fig.* 3.) as A E: B D :: A F : B L. Then, As the Cylinder G E, is to the Cylinder I D; ſo is the Requiſit of Pouder in G F, to the Requiſit of Pouder in I L. But as quantity is to quantity, ſo is weight to weight being of the ſame kind. Therefore, As the ſquare of A G, in A E, is to the ſquare of B I, in B D; ſo is the weight of the Pouder in G F, to the weight of the Pouder in I L.

Prop.

Propoſition VII.

The Length of the Chaſe, diameter of the bore and Greateſt Randon of any Peece; with the Length of the Chaſe and diameter of the bore of any other Peece, being given; To find its Greateſt Randon.

(In *Fig.* 3.) Let X Y = Z R; Then, as A E is to B D; ſo is the Range of the Cylinder H V, to the Range of the Cylinder K N. But as C X is to Y X; ſo is the Range of the Cylinder K N, to the Range of the Cylinder K M. That is, as A E in X C, is to B D in Z R; ſo is the Range of the Cylinder H V, to the Range of the Cylinder K M. But a Sphere is two thirds of its circumſcribed Cylinder; therefore the Ranges of the Bullets are in the ſame proportion.

Propoſition VIII.

The Length of the Chaſe, diameter of the bore and force of any Peece being given; with the Length of the Chaſe, and diameter of the bore of any other Peece being alſo given; To find its Force.

Here we compare (for examples ſake) the Baſilisk with the Culverin; And ſuppoſing the force of the Culverin to be the Cube of the diameter of the Bore thereof in half Inches, *viz.* 1000. As the length of the Culverin, is to the length of the Baſilisk in the diameter of the Bore of the Culverin; ſo is the fift power of the diameter of the Bore of the Baſilisk, to a number whoſe ſquare root is the force of the Baſiliſk, comparatively to that of the Culverin.

Propoſition IX.

The Length of the Chaſe and diameter of the bore of any Peece, with the Time of the ſhot in its flight; with the Length of the Chaſe, and diameter of the bore of any other Peece being alſo given; To find the Time or duration of the Shot in its flight.

Suppoſe the time of the Culverin 1000; As the ſeventh Power of the Diameter of the Bore of the Baſilisk, in the length of the Culverin; is to the ſeventh Power of the Diameter of the Bore of the Culverin, in the length of the Baſilisk: So is the ſquare of the Time of the Culverin, to the ſquare of the Time of the Baſilisk.

Propoſition X.

The length of a Peece and Requiſit of Pouder being given; To find the Diameter of its Bore.

Now comparing the Culverin with any other Peece; As the Requiſit of Pouder of the Culverin, is to the Requiſit given; ſo is the ſquare of the Diameter of the Bore of the Culverin in its length, to a fourth number; this fourth number being divided by the given length, the ſquare root of the quotient is the Diameter ſought.

Propoſition XI.

The diameter of the Bore and Requiſit of Pouder being given; To find the Length.

As the Requiſit of Pouder of the Culverin, is to the Requiſit given; ſo is the length of the Culverin in the ſquare of its diameter, to a fourth number, which being divided by the ſquare of the given diameter, is the length ſought.

Prop.

Propoſition XII.

The length of a Peece and Randon being given; To find the diameter of its Bore.

As the length of the Culverin in the given Randon, is to the length given in the Randon of the Culverin; ſo is the diameter of the Bore of the Culverin, to the diameter ſought.

Propoſition XIII.

The Diameter and Randon being given; To find the length.

As the Diameter of the Culverin in its Randon, is to the Diameter given in the given Randon; ſo is the length of the Culverin, to the length ſought.

Propoſition XIV.

The Force and length of any Peece being given; To find the Diameter of its Bore.

As the length of the given Peece in the diameter of the Bore of the Culverin, is to the length of the Culverin; ſo is the ſquare of the Force given, to the fift Power of the Diameter ſought.

Propoſition XV.

The Diameter and Force being given; to find the Length.

As the Diameter of the Culverin in the fift power of the given Diameter, is to the length of the Culverin; ſo is the ſquare of the Force given, to the length ſought.

Prop. XVI.

The Greateſt Randon and weight of the ſhot being given; To find the time or duration.

As the Greateſt Randon of the Culverin in the ſquare of the weight of the ſhot of the Baſilisk, is to the Greateſt Randon of the Baſilisk in the ſquare of the weight of the ſhot of the Culverin; ſo is the ſquare of the time of the Culverin, to the ſquare of the time of the Baſilisk.

Prop. XVII.

The Time and weight of the ſhot being given; To find the Greateſt Randon.

As the ſquare of the time of the Culverin in the ſquare of the weight of its ſhot, is to the ſquare of the time of the Baſilisk in the ſquare of the weight of its ſhot; ſo is the Greateſt Randon of the Culverin, to the Greateſt Randon of the Baſilisk.

Prop. XVIII.

The time and Greateſt Randon being given; To find the weight of the ſhot.

As the ſquare of the time of the Baſilisk in the Greateſt Randon of the Culverin, is to the ſquare of the time of the Culverin, in the Greateſt Randon of the Baſilisk; ſo is the ſquare of the weight of the ſhot of the Culverin, to the ſquare of the weight of the ſhot of the Baſilisk.

Prop. XIX.

The time and diameter of the bore being given; To find the length of the Peece.

As the ſquare of the time of the Culverin in the ſeventh power of the diameter of its bore, is to the ſquare of the time of the Baſilisk in the ſeventh power of the diameter of its bore; ſo is the Length of the Culverin, to the Length of the Baſilisk.

Prop. XX.

The time and diameter of the bore being given; To find the force.

As the time of the Culverin in the cube of the diameter of its bore, is to the ſixth power of the diameter of the bore of the Baſilisk; ſo is the time of the Baſilisk, to its force.

Prop. XXI.

The time and length of the Chaſe being given; To find the diameter of the bore.

As the Length of the Chaſe of the Culverin in the ſquare of the time of the Baſilisk, is to the Length of the Baſilisk in the ſquare of the time of the Culverin, ſo is the ſeventh power of the Diameter of the Bore of the Culverin, to the ſeventh power of the diameter of the Baſilisk.

Prop. XXII.

The diameter of the Bore and force being given; To find the Time.

As the ſixth power of the diameter of the bore of the Baſilisk, is to the time of the Culverin in the cube of the diameter of its bore; ſo is the force of the Baſilisk, to its time.

Prop.

Prop. XXIII.

The time and force being given; To find the diameter of the bore.

As the time of the Baſilisk, is to its force; ſo is the time of the Culverin in the cube of the diameter of its bore, to the ſixth power of the diameter of the bore of the Baſilisk.

Prop. XXIV.

The Greateſt Randon and diameter of the bore being given; To find the force.

As the Greateſt Randon of the Culverin, is to the Greateſt Randon of the Baſilisk; ſo is the ſixth power of the diameter of the bore of the Baſilisk, to the ſquare of its force.

Prop. XXV.

The Greateſt Randon and force being given; To find the diameter of the Bore.

As the Greateſt Randon of the Baſilisk, is to the Greateſt Randon of the Culverin; ſo is the ſquare of the force, to the ſixth power of the diameter of its bore.

Prop. XXVI.

The diameter of the bore and force being given; To find the Greateſt Randon.

As the ſixth power of the diameter of the bore of the Baſilisk, is to the ſquare of its force; ſo is the Greateſt Randon of the Culverin, to the Greateſt Randon of the Baſilisk.

Prop.

Prop. XXVII.

The Time and Greateſt Randon being given; To find the diameter of the bore.

As the Greateſt Randon of the Culverin, in the ſquare of the time of the Baſilisk; is to the Greateſt Randon of the Baſilisk, in the ſquare of the time of the Culverin: ſo is the ſixth power of the diameter of the bore of the Culverin, to the ſixth power of the diameter of the bore of the Baſilisk.

Prop. XXVIII.

The diameter of the bore and Greateſt Randon being given; To find the Time.

As the ſixth power of the diameter of the Baſilisk, in the Greateſt Randon of the Culverin; is to the ſixth power of the diameter of the bore of the Culverin, in the Greateſt Randon of the Baſilisk: ſo is the ſquare of the time of the Culverin, to the ſquare of the time of the Baſilisk.

Prop. XXIX.

The diameter of the bore and time being given; To find the Greateſt Randon.

As the ſquare of the time of the Culverin, in the ſixth power of the diameter of its bore; is to the ſquare of the time of the Baſilisk, in the ſixth power of the diameter of its bore: ſo is the Greateſt Randon of the Culverin, to the Greateſt Randon of the Baſilisk.

Prop.

Prop. XXX.

The diameter of the Bore, weight of the Shot and force being given; To find the Time.

As the cube of the diameter of the Baſilisk in the weight of its ſhot, is to the force of the Baſilisk in the weight of the ſhot of the Culverin; ſo is the time of the Culverin to the time of the Baſilisk.

Prop. XXXI.

The time, weight of the ſhot and force being given; To find the diameter of the bore.

As the time of the Baſilisk, in the weight of its ſhot, is to the force of the Baſilisk in the weight of the ſhot of the Culverin; ſo is the time of the Culverin, to the cube of the diameter of the bore of the Baſilisk.

Prop. XXXII.

The Time, diameter of the bore, and weight of the ſhot being given; To find the force.

As the weight of the ſhot of the Culverin in its time, is to the weight of the ſhot of the Baſilisk in its time; ſo is the cube of the diameter of the bore of the Baſilisk to the force of the Baſilisk.

Prop. XXXIII.

The diameter of the bore, Time and force being given; To find the weight of the ſhot.

As the cube of the diameter of the bore of the Baſilisk in its time, is to the weight of the ſhot of the Culverin in its time; ſo is the force of the Baſilisk, to the weight of its ſhot.

Prop.

Prop. XXXIV.

Two Peeces of the ſame length, have their Ranges in Reciprocal proportion to the Diameters of their Bores.

Prop. XXXV.

Two Peeces of the ſame Bore, their Ranges are as the length of their Chaſes.

Prop. XXXVI.

Two Peeces whoſe length of Chaſes and Diameters of their Bores are directly proportional, their Ranges are equal, but their Forces and Times in reciprocal proportion.

Prop. XXXVII.

If any Peece, having conſtantly the ſame force and quantity of Pouder, be diſcharged ſeveral times at the ſame Elevation, with ſeveral ſhot of equal magnitude, but of different weight, as Lead, Iron, Stone, *&c.* The Ranges upon the plane of the Horizon ſhall be all in Reciprocal proportion to the weight of the Shot.

Concerning the Morter-Peece.

Propoſition XXXVIII.

If in two Morter Peeces, *viz.* E and F; the lines A B, C D, E F, I H, and H G, be in Proportion as the lines K M, N P, Q Z, X O and O L, (as uſually they are) ſuch are like Morter-Peeces: If the Requiſit of Pouder of E, be to the Requiſit of Pouder of F, and the weight of the Shot of E to the weight of the Shot of F, as the Cubes of the Diameters of their Bores (as they ought to be) their Randons under the like Elevations and upon the like planes, will be equal.

Propoſition XXXIX.

The Diameter of the Bore and weight of the Shot being given, To find the Greateſt Randon.

If the weight of their Shot be not as the Cubes of the Diameters of their Bores, as it often happens; Then, As the Cube of the Diameter of the Bore of E in the weight of the Shot of F, is to the Cube of the Diameter of the Bore of F in the weight of the Shot of E; So is the Range of the Shot of E, to the Range of the Shot of F.

Prop. XL.

The Diameter of the Bore and the Greateſt Randon being given, To find the weight of the Shot.

As the Cube of the Diameter of the Bore of E in its Randon, is to the Cube of the Diameter of the Bore of F in its like Randon; So is the weight of the Shot of E, to the weight of the Shot of F.

Prop. XLI.

The Randon and weight of the Shot being given, To find the Diameter of the Bore.

As the weight of the Shot of E in the Greateſt Randon of F, is to the weight of the Shot of F in the Greateſt Randon of E; ſo is the Cube of the Diameter of E to the Cube of the Diameter of F.

Prop.

Prop. XLII.

The Diameter of the Bore and weight of the Shot being given; To find the Time of the Shot in its flight.

As the weight of the Shot of E, in the Cube of its Diameter, is to the weight of the Shot of F in the Cube of its Diameter; So is the Square of the Time of the Shot of E, to the Square of the Time of the Shot of F; when under the like Elevations and upon the like Plaines.

Concerning the ſhooting of Granados out of Long Gunnes, as ſuppoſe a Cannon and a Demy-Cannon, &c. wherein the Requiſits of Pouder are found by *Prop.* VI.

Prop. XLIII.

The length of the Chaſe, Diameter of the Bore, and the weight of the Shot being given; To find the Greateſt Randon.

As the length of the Chaſe of the Cannon in the ſquare of its Diameter, in the weight of the Shot of the Demy-Cannon; is to the length of the Chaſe of the Demy-Cannon in the ſquare of its Diameter, in the weight of the Shot of the Cannon; ſo is the Greateſt Range of the Cannon, to the Greateſt Range of the Demy-Cannon.

Prop.

Propoſition XLIV.

The length of the Chaſe, Diameter of the Bore and Greateſt Randon being given; To find the weight of the ſhot.

As the length of the Chaſe of the Cannon, in the ſquare of its Diameter, in the Greateſt Randon of the Demy-Cannon, is to the length of the Chaſe of the Demy-Cannon in the ſquare of its Diameter, in the Greateſt Randon of the Cannon; ſo is the weight of the ſhot of the Cannon, to the weight of the ſhot of the Demy-Cannon.

Prop. XLV.

The length of the Chaſe, Greateſt Randon, and weight of the ſhot being given; To find the Diameter of the Bore.

As the weight of the ſhot of the Cannon in its Greateſt Randon, in the length of the Demy-Cannon; is to the weight of the ſhot of the Demy-Cannon in its Greateſt Randon in the length of the Chaſe of the Cannon; ſo is the ſquare of the Diameter of the Cannon, to the ſquare of the Diameter of the Bore of the Demy-Cannon.

Prop. XLVI.

The weight of the ſhot, Greateſt Randon, and Diameter of the Bore being given; To find the length of the Chaſe.

As the weight of the ſhot of the Cannon in its Greateſt Randon, in the ſquare of the Diameter of the Bore of the Demy-Cannon, is to the weight of the ſhot of the Demy-Cannon in its Greateſt Randon, in the ſquare of the Diameter of the Bore of the Cannon; ſo is the length of the Chaſe of the Cannon, to the length of the Chaſe of the Demy-Cannon.

Prop.

Prop. XLVII.

The length of the Chaſe, Diameter of the Bore, and weight of the ſhot being given; To find the Duration of the ſhot in its flight in the Air.

As the length of the Chaſe of the Cannon in the ſquare of of its Diameter, in the Cube of the weight of the ſhot of the Demy-Cannon; is to the length of the Chaſe of the Demy-Cannon in the ſquare of its Diameter, in the Cube of the weight of the ſhot of the Cannon; So is the ſquare of the Time of the Cannon ſhot, to the ſquare of the Time of the Demy-Cannon ſhot, when under like Elevation and upon like planes.

Prop. XLVIII.

The Diameter of the Bore, weight of the ſhot, and Time being given; To find the length of the Chaſe.

As the Cube of the weight of the ſhot of the Cannon, in the ſquare of its Time, in the ſquare of the Diameter of the Bore of the Demy-Cannon; is to the Cube of the weight of the ſhot of the Demy-Cannon, in the ſquare of its Time, in the ſquare of the Diameter of the Bore of the Cannon: ſo is the length of the Chaſe of the Cannon, to the length of the Chaſe of the Demy-Cannon.

Prop. XLIX.

The length of the Chaſe, weight of the ſhot, and time being given; To find the Diameter of the Bore.

As the Cube of the weight of the ſhot of the Cannon, in the ſquare of its Time, in the length of the Chaſe of the Demy-Cannon; is to the Cube of the ſhot of the Demy-Cannon in the ſquare of its Time, in the length of the Chaſe of the Cannon: ſo is the ſquare of the Diameter of the Bore of the Cannon, to the ſquare of the Diameter of the Demy-Cannon.

Propoſition L.

The length of the Chaſe, Diameter of the Bore and Time being given; To find the weight of the ſhot.

As the length of the Chaſe of the Cannon, in the ſquare of the Diameter of its Bore, in the ſquare of the time of the Demy-Cannon; is to the length of the Chaſe of the Demy-Cannon, in the ſquare of the Diameter of its Bore, in the ſquare of the time of the Cannon: ſo is the Cube of the weight of the ſhot of the Cannon, to the Cube of the weight of the ſhot of the Demy-Cannon.

Thus

THus have I ſet down fifty Propoſitions concerning practical Gunnery, every one of them new, and not done as I know of by any other; I could produce many more, but here I ſhall briefly ſhew the uſe of ſome of theſe. By the firſt four, from any ſhot made we find the Greateſt Random; By the V, we ſtrike any place at demand, without which no Rational man can account himſelf a compleat Canonier; By the V I, we give every Gunne its due Charge, and without this no man can, ſo readily as he ought, be able to hit the mark conſtantly and according to Art: By the V I I, a Gunner may know which of his Gunnes will reach the Enemy; By the V I I I, X X, X X I V, and X X X I I, he may know the Execution or Force of each Peece, and ſo to make choice of Gunnes for his purpoſe; By the I X, X V I, X X I I, X X V I I I, and X X X, he gives the ſhot of every Gunne its due time, ſo that diſcharging many Peeces, their ſhot may arrive at the Enemy at the ſame time: By the X I, is Reſolved that which *COUNT MAURICE PRINCE of ORANGE* endeavoured to do, by cutting a Gunne ſhorter foot by foot, *viz.* A quantity of Pouder, and the Diameter of the Bore being given; To find the length of the Peece. *Hexham* Part 3. pag. 3.

As alſo, at the end of *Military Diſcipline*, pag. 68. it is thus. *It hath been obſerved by a Noble man who Related it to me, that a Field Gunne eighteen foot long, and cut ſhorter foot by foot, did always curry its ſhot the farther, till it came to be eleven foot long, and then it began not to give ſo great a Range.*

Alſo, that where the Gunne is found moſt to furr with many ſhootings off with Pouder, there it ought to be cut off, the Remainder being the proper length Requiſite.

But here we do it at an eaſier Rate than to cut Gunnes ſhorter foot by foot; as alſo we may be very ſure, that a Gunne cannot be too long, if it hath ſtrength to bear its Requiſit of Pouder.

By the X X X V I I I, We learn the nature of Morter-Peeces: By the X X X I X, X L, X L I and X L I I, is ſhewed

the uſe of the ſame: By the XLIII, XLIV, XLV XLVI, XLVII, XLVIII, XLIX, and L, is delivered a method of ſhooting Granados out of long Gunnes.

By this a Gunne-founder may found Gunnes according to demand; either for *Range*, *Force*, or *Time*.

BY this new Art and Method of ſhooting, may Cannoneers either with Great ſhot or Granados, or with ſmall ſhot out of Great Gunnes, do ſtrange execution on an Enemy at a conſiderable diſtance.

By this, from a Caſtle or Fort, taking the diſtances at leiſure to all ſuch places by which an Enemy may approach, the Enemy may receive ſo much detriment that it will be impoſſible for him to be Maſter of that Fort or Caſtle by Storm.

The like ſervice may be done from any Caſtle or Fort upon Ships at Sea, at great diſtances.

By this may an Army and the General himſelf in his Tent be extreamly annoyed, although at 4, 6, or 8 miles diſtance.

By this a Fire-Maſter may lay his Granado or Fire-ball at any place at demand, and give its Fuſee its juſt time.

By this the Commander of an Army may ſpeedily win the Field; perform unexpected Batteries at great diſtances, and deſtroy many of his Enemies before they think themſelves within the reach and danger of the Artilery.

And this may be alſo of great uſe and advantage at Sea or in Sea-fights, though there the Direction of a Peece is always leſs certain than at Land.

IF any ſhould ask how I came to know theſe things being no practical Gunner, *&c.* It is anſwered;

Firſt; They are proved by Mathematical Demonſtration, which is more ſatisfactory than Mechanick tryal.

2. That experiments might not be wholly neglected, I made a *Tube* in form of a *Parallelepipedon*, I meaſured the middle from each end thereof, and from that middle point I meaſured equal diſtances towards each end, there I made holes into which I put in like pinns with equal holes pierced through:

I ſet this *Tube* exactly Horizontal, keeping it always full of water; Then I obſerved that the two ſtreams of water iſſuing from

from those pipes were coincident at the plain of the bottom of the *Tube*. *Torricellius De motu aquarum.*

3. I made tryal by a Steel-Bow set fast in a Carriage, The Ranges equidistant above and below 45 degrees being equal upon the plain of the Horizon, and every where agreeing with the *Parabola*.

4. By a Brass Gunne founded at my own charge; having found (by the 5) the degree of Elevation or depression, I ordered it thus: I made a Cylinder of wood about a foot and half long, very fit for the Chase of the Peece, about half the length I took away half the thickness of this Cylinder, thereunto I applyed and made fast a true plain with a Plummet and with two pinns to hang the Quadrant on; This Cylinder being put into the Muzzle of the Peece, the plain put vertical by its Plummet, and a smal Telescope applyed to that plain, gives the direction and Elevation of the Peece precisely; with screwes I set both Peece and carriage so fast that it moved no more than the Earth; and thus I layd it to pass.

By this means may Carriages be made at a cheaper rate than formerly, and that mighty Engine the Gunne be set firm and fast, for the making of a shot readily and perfectly according to Mathematical principles, without which the whole Art of Gunnery is extreamly deficient.

Lastly, I caused a *Pendulum* motion to be made with two wheeles, to measure the Time of the shot in its flight, and so to give both shot and fusee their just times.

A Table of the Names, Diameters of the Bores, and lengths of the Chaſes of 12 ſeveral Peeces of Cannon: with their Requiſits of Pouder, Greateſt Randons, and Comparative Forces and Times, by Mathematical Demonſtration.

The Name of each Peece.	Diam: of the Bore.	Length of the Chaſe	Requiſit of Pouder.	Greateſt Randon.	Compar. Force.	Compar. Time.
	Inches	Feet.	Pounds	Miles		
A Rabbinet.	1.75	3	0.333	3.769	38	20589
A Falconet.	2.	4	0.580	4.398	61	14898
A Falcon.	2.75	6	1.646	4.797	166	5986
A Minion.	3.	8	2.612	5.864	238	5097
A Saker.	3.5	9	4.000	5.654	371	3152
A Demy-Culverin.	4.5	10	7.347	4.886	733	1379
A Culverin.	5.	11	9.977	4.837	1000	1000
A Demy-Cannon.	6.	11	14.367	4.031	1577	528
A Whole Cannon.	7.	12	21.333	3.769	2422	322
A Cannon Royal.	8.	12	27.864	3.298	3382	202
A Long Culverin. in *Dial* Caſtle.	4.75	16	13.098	7.407	1061	1443
A Baſilisk in *Dover* Caſtle.	4.6	23.5	18.041	11.233	1187	1957

For further Explanation of this Table; In the firſt Column, we have the Name of each peece; In the ſecond the Diameters of their Bores in inches and decimals of an inch; In the third, the length of their Chaſes in feet and decimals of a foot; In the fourth the Requiſit of Pouder to each Peece in pounds and decimals of a pound, ſuppoſing four pounds to be the Requiſit of the Saker; In the firſt, their Greateſt Randons, in Miles and decimals of a Mile, ſuppoſing the Greateſt Randon of the Saker 5 Miles, 654 paces, as it hath been found by many experiments; In the ſixt, their comparative Forces one to another when taken in like places; In the ſeventh, the comparative Times of the Ranges of their ſhot in like Elevations.

Obj.

Objections againſt this new Method of Shooting Anſwered.

Objections.

1. That it is Impoſſible.
2. That the Ranges can not be ſo great.
3. That the wind hinders the flight of the Shot, ſo that no certain ſhot can be made at thoſe great diſtances.
4. That it will be ſo troubleſom, that it cannot be uſed ſo readily as ſervice requires.

Anſwers.

1. To the firſt; That general Objection is, for want of Art, Experience, and a due conſideration.

2. That the Ranges are ſo great, we prove from many ſhot made with ſeveral Great Gunnes, eſpecially with the Saker, as in the firſt, ſecond and third Propoſition; which ſhot were made with care, by *Eldred* Gunner of *Dover* Caſtle; then, from the Complication by the ſeventh, which no rational Mathematician can deny: Further, by my own experience; A Braſs Gun which I cauſed to be founded, being but 17 inches in the Chaſe, and three inches three tenths of an inch in the diameter of the Bore (which is a Saker Bore of the leſſer ſize) with three ounees of pouder, Ranges a Braſs ſhot ſomewhat more than a Mile; ſo then, if this quantity of pouder and length of Chaſe be taken ſix-fold, a Peece of 8 foot and an half in the Chaſe, the Diameter of the Bore being three inches three tenths, with one pound and two ounces of Pouder, Ranges its ſhot more than ſix Miles, by Prop. XXXV. But the Requiſit of Pouder of ſuch a Peece, is near

near 4 pounds by Prop. VI. therefore let any rational man make tryal and give every Peece its due Charge, setting the Peece fast and making the Bullet fit, and he shall find the Ranges and Forces to be much greater than what I here set down: for I charged a Peece of 8 inches in length in the Chase and four fifths of an inch in the Diameter of the Bore, with one eighth part of an ounce of Pouder, and a small Granado of an ounce weight, closing the pouder with a tampion of Cork; this being discharged, ranged that Granado more than half a Mile.

I also charged a Peece of 18 inches in the Chase and four fifts of an inch in the Diameter of the Bore, with one eighth part of an ounce of pouder and a fit lead shot and laid it Horizontally, discharging it against a brick-wall at threescore yards distance, and could not discern the shot any whit to decline, it never missing the mark more than three inches.

Here I could produce many more experiments, and they of different kinds, all proving as well the greatness of the Ranges as the exactness of the flight of the shot of Peeces of all sorts; but these may here suffice: only note by the way, that the common supposition of Gunners is, that the Diameter of the Bullet ought to be one twentieth part less than the Diameter of the bore of the Peece; which need not be, for I made the aforesaid shot very fit and so used them.

3. That the Wind hinders not the flight of the shot as is objected; I have made more than an hundred shot, and many in very windy days at near half a mile distance, and could never find the Bullet to be any whit hindered by the wind: And if we consider with what violence and in what short time a Bullet is in its flight, we may easily apprehend the wind to have little or no hold on it. Also, from common experience, we find the Wind seldom throws down houses, though they be very old, yet a Cannon Bullet shot out of a Cannon, will throw down a Castle Wall. And lastly, those shot which I made with the aforementioned Gunne with 3 ounces of Pouder, commonly struck the shot 4 feet into the Earth, from which if we calculate the Impetus of a Cannon-Royal by the

the 8 hereof, we ſhall find the force thereof to be 27 times greater than the Impetus of that Peece, from which we may very well conclude, a Cannon Bullet flies with greacer force than for the wind to drive it out of its way. Here note; the Wind and Air takes hold of Bullets as ſquares; but the force is as Cubes, and that under a five fold conſideration.

4. That it is not ſo troubleſome, &c.: If we conſider the notable execution that may be performed by this method, we ſhall find there is no compariſon between this and that which Gunners commonly uſe; for their common way, is to make a ſhot by gueſs, and then to mend the next as they ſee occaſion, or elſe uſe ſuch tables of Randons as are contrary to all truth and demonſtration: But by this new way, we take the diſtance and then give the Peece its juſt Elevation according to Art by Prop. V; by which one Peece of Cannon in one hour, will do more execution than by the uſual way in ſix, although they make more ſhot in every hour.

THus have I ſufficiently anſwered thoſe four Objections; And here I affirm from Art and Experience;

Firſt, that the Wind, Air, ſhaking of the Earth and Peece, and all other impediments conſidered, a Canonier may ſtrike the mark at all times, within twelve paces in a Mile, in any diſtance within the reach of the peece: and thus may a Caſtle or Fort, or a Brigade of Men be annoyed, at one, two, or three Miles diſtance.

2. That no Batteries or Approaches within the ſaid diſtance of one two or three Miles, can be raiſed, made or carried on, without great loſs of men to the beſieger, if the beſieged have Cannon-Royal, Cannon, Demy-Cannon, Culverin, or Demy-Culverin.

3. That all other ſtratagems yet publiquely known, will be of little validity againſt the beſieged, becauſe they being readily prepared, their great Gunnes will make ſuch irrepairable breaches upon the beſiegers, that their work will be to little or no purpoſe.

4. But as well modern as ancient Writers of Fortification, give much ſhorter limits than one two or three Miles, both for

the

the Redouts and Breaking of ground for their Approaches; *viz. Gouldman, Lib. quart.* pag. 317. begins to break ground at 200 Paces or leſs. *Hexham* Part. 2. Pag. 37. breaks ground at 90 Rods. *Military Architecture*, Pag. 47. opens the Trench about 200 Paces from the Town. The Author of *Enchiridion*, Pag. 42. ſayes at musquet-ſhot. But Sir *Jonas Moor* in his *Modern Fortification*, Pag. 18, at 9. ſayes the length of the Port of a Muſquet doth not much exceed 160 paces, and Pag. 102. at 2, that the line of Contravallation called the breaking of ground, is to be choſen beyond Muſquet-ſhot or Falcon from the Town, and Pag. 103. at 4, begins the line of Approaches 240 Paces from the Town.

5. Therefore, all Engineers as well ancient as Modern (were they now together alive) muſt begin their works again, and contrive ſome other Machinations, to countermand the force of this violent Engine the Gunne thus managed.

6. Touching Fortification; It was not my intent in 1672, when this work was firſt preſented to the view of his Grace the Duke of *Monmouth*; it indeed being in it ſelf (at the beſt) ſo mean a thing, that there is no more of the Mathematicks applicable thereunto, then the uſual Doctrine of plain Triangles, and the meaſuring of plain Solides, with the help of common ditching and banking; ſo that, the meaneſt among Mathematical fancies, are ſufficient for the carrying on of all manner of fortifications whatſoever.

7. Nor was my intention any thing of ſportive fireworks, or more plainly Squibs and Crackers; that being in it ſelf ſo very mean, that it calls to its aſſiſtance little elſe than meer dirt and drudgery.

8. My Intention was this herein contained, which I have brought thus forward in order to a nearer compleating of the Art of Gunnery, wherein I am very well aſſured, I have done more being a private perſon, than all the Engineers and Gunners with their yearly ſalaries and allowances, ſince the firſt Invention of this Warlike Engine; and I ſhall (God willing) as time and opportunity gives leave, do much more: this being done to ſatisfy my ſelf, and publiſhed for the defence of my native Country, without having any mans parts or perſon in admiration for advantage ſake.

And

And for the Construction of the Tables of Projection, take these following Rules.

For Ascents, Fig. 2.

IN the *Parabola* Z O F: Z K, K F, and G H the greatest Altitude being given; we find all the lines K O; then setting all the lines Z K and K O in a Table, the Angle K Z R will be found, as hereafter shall appear.

But here observe that the lines K O have their second differences equal, as is proved by the following Table; In which let A be equal to Z F, and B equal to the subdivision of Z F.

In the first column are the Rectangles; In the second, the First differences; In the third, the Second differences and they equal.

1. The Rectangles.	2. First Diff.	3. Second Diff.
0 — 0		
	A B — 1 B².	
1 A B — 1 B².		—2 B².
	A B — 3 B².	
2 A B — 4 B².		—2 B².
	A B — 5 B².	
3 A B — 9 B².		—2 B².
	A B — 7 B².	
4 A B — 16 B².		—2 B².
	A B — 9 B².	
5 A B — 25 B².		—2 B².
	A B — 11 B².	
6 A B — 36 B².		—2 B².
	A B — 13 B².	
7 A B — 49 B².		—2 B².
	A B — 15 B².	
8 A B — 64 B².		—2 B².
	A B — 17 B².	
9 A B — 81 B².		—2 B².
	A B — 19 B².	
10 A B — 100 B².		—2 B².
	A B — 19 B².	
9 A B — 81 B².		—2 B².
	A B — 17 B².	
8 A B — 64 B².		—2 B².
	A B — 15 B².	
7 A B — 49 B².		—2 B².
	A B — 13 B².	
6 A B — 36 B².		—2 B².
	A B — 11 B².	
5 A B — 25 B².		—2 B².
	A B — 9 B².	
4 A B — 16 B².		—2 B².
	A B — 7 B².	
3 A B — 9 B².		—2 B².
	A B — 5 B².	
2 A B — 4 B².		—2 B².
	A B — 3 B².	
1 A B — 1 B².		

To find the Second, and any of the First Differences at Demand.

For the 87th. Degree of Elevation; Let Z F be equal to 209057: the ſubdiviſion 10000: and G H the greateſt Altitude 997261.

To find the ſecond Difference, obſerve the third Column, that is, ſquare the ſubdiviſion 10000: the ſquare is 100000000, doubled 200000000.

Z G 104528.5	——	5.019235
Its ſquare	——	10.038470
200000000	——	8.301030
G H. 997261	——	5.998809
		14.299839
The ſecond difference. 18254.5	——	4.261369

To find any of the First Differences at Demand; ſuppoſe the 9th. excluſive, or 10th. incluſive.

Obſerve the ſecond column, A B—19B², that is, the product of the whole baſe in the ſubdiviſion, leſs the ſquare of the ſubdiviſion in the double of the number of terms more by 1 excluſive, or leſs by 1 incluſive; thus, 2090570000, leſs 1900000000, is 190570000. Then,

The ſquare of Z G.	——	10.038470
The Altitude of the Parabola, G H	——	5.998809
The number now found, 190570000	——	8.280055
		14.278864
The firſt difference —— 17393.8	——	4.240394

Then, by Addition and Subduction, may all the Altitudes (for that degree) be found, as appeareth by the Columnes of the former Table.

But

But otherwiſe to find any of the Altitudes, ſuppoſe the 9th.

Obſerve the firſt column, 9 A B leſs 81 B^2, That is, the product of the whole baſe in 9 in the ſubdiviſion, leſs the ſquare of the number of terms in the ſquare of the ſubdiviſion, thus,

209057, in 9, in 10000, is——————18815130000
Leſs 81 in 100000000, that is——————8100000000
Their difference is——————10715130000

10715130000——————10.029997
The Altitude of the Parabola, G H.——————5.998809
16.028806
The ſquare of Z G, ſub.——————10.038470
The Altitude, K O.——977995——————5.990336

To Calculate the Table for Deſcents:

In the Parabola B Z H F E, the Angle of Elevation or Depreſſion G Z I, together with the lines Z G and G H, and the Deſcent Z P being given; To find P V = I C.

Suppoſe the Angle G Z I 3 degrees, Z G 1045.3 *ferè*, G H, 27. 4 *ferè*, Z C = G D. 10000, and the ſubdiviſion Z P = G L. 100.

The Log. of the ſquare of Z G, is——————6.03847
The Log. of G H Subſtract.——————1.43761
The Log. of the Parameter Y——————4.60086
H G + G L = H L. Log. Add——————2.10514
Take the half of this Log.——————6.70600
L V (by 11 Prop. 1 Apoll.) 2254——————3.35300
L P = Z G——————1045
The Sum is P V——————3299. for Elevation.
The Difference, P V——————1209. for Depreſſion.

Then, by all the lines Z P and P V, The Angle C Z A or its complement G Z I, may be found, as in that for Aſcents.

If

For Concluſion to this Treatiſe.

If any one elſe ſhall arrogate to himſelf, the knowledg of what is herein contained afore this was publiſhed; let him reſolve theſe two following Propoſitions, viz.

First (In *Fig.* 2) Z C, C E and the Angle C Z A, being given, To find B C: Let C E = A, C Z = B, the tangent of the Angle C Z A = T, the Radius = R, and B C = Z. Then $\frac{A+Z}{2}$ = B D, and $\frac{A-Z}{2}$ = Z G in the Diagram: Further, As R : T :: $\frac{A-Z}{2}$: G I. in the Diagram; that is $\frac{AT-ZT}{4R}$ = G H, and $\frac{AT-ZT+4BR}{4R}$ = H D in the Diagram. Then $\frac{A^2R-2AZR+Z^2R}{AT-ZT}$ = Y. and $\frac{A^2R+2AZR+Z^2R}{AT-ZT+4BR}$ = Y. by the 11 of the 1 of *Apollonius*; Therefore $\frac{A^2+2AZ+Z^2}{AT-ZT+4BR}$ = $\frac{A^2-2AZ-Z^2}{AT-ZT}$, This being Reduced riſeth to an Adfected ſquare Æquation. But the third Propoſition hereof Reſolves it without *Algebra*. I deſire him to do the like in other uſeful Propoſitions riſing to a ſquare Adfected Æquation, but chiefly (as to our preſent purpoſe) the 5 hereof, or ſhew the reaſon why it cannot be done.

And ſecondly; The length of the Chaſe, Diameter of the Bore, Requiſit of Pouder and Greateſt Randon of a Cannon, being given, as alſo the dimenſions of a Morter-Peece or Bombard; To find the Requiſit of Pouder and Greateſt Randon of this Morter-Peece or Bombard.

And if he cannot reſolve theſe; I have them both in readineſs, with other of the like kind.

Jan. 14. 1633.

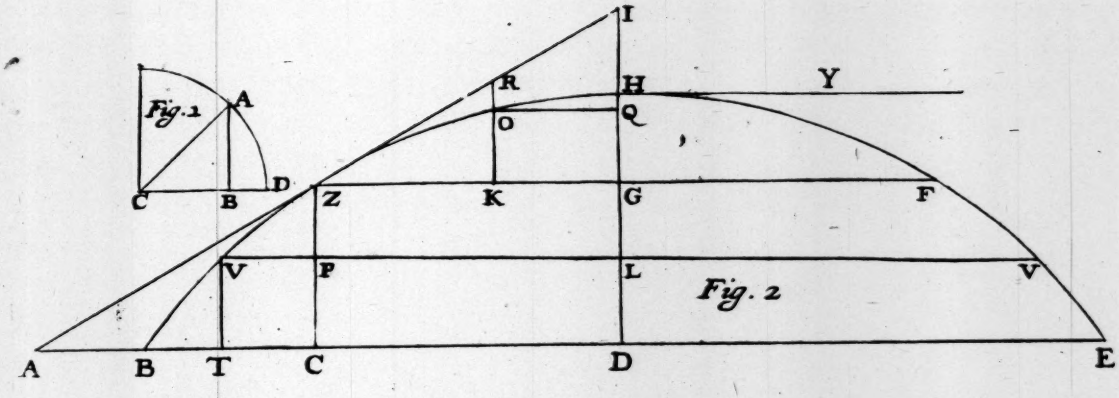


Fig. 2

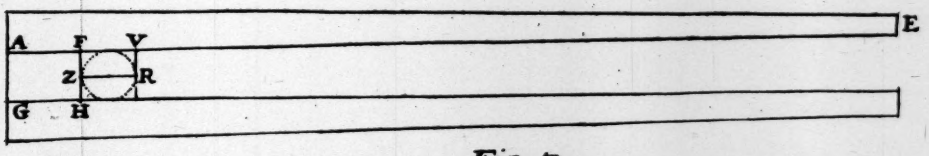
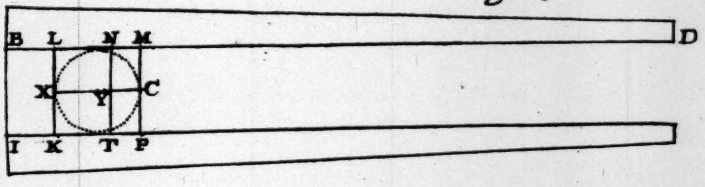
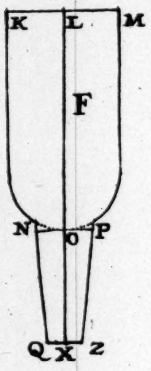
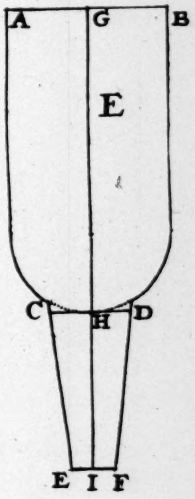


Fig 3







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For Concluſion to this Treatiſe.

Tables of Projection, &c.
Exactly calculated and their Uſe exemplified,

BY

THOMAS STREETE

The Uſe of the next following Table, for finding the Greateſt Randon by the Elevation and anſwerable Randon of any Peece, is thus:

AGainſt the Degree of the given Elevation on the left hand, and under the minute, or tenth of a Degree on the top; or, againſt the Degree of the ſaid Elevation on the right hand, and over the minute, or tenth of a degree in the bottom; find the Tabular Horizontal Diſtance.

Then; As this Tabular Diſtance, is to 2000, So is the given Randon of the Peece, to the Greateſt Randon ſought.

Example.

A Culverin Elevated 10 Degrees and 5 tenths or 30 minutes, laying his Ball at the Horizontal Diſtance of 1734, Paces; To find his Greateſt Randon.

In the Table, againſt 10 Degrees on the left, and under 5 tenths on the top, is 717, the Tabular Diſtance.

Therefore; as 717, is to 2000, So is 1734, to 4837 Paces, the Greateſt Randon of the ſaid Peece.

The ſame would follow if the Elevation had been 79 Degrees and 5 tenths, as on the right hand and in the bottom of the Table.

The Uſe of this and the other Tables for making of a Shot at any place at demand, ſhall be ſhewn in the latter end hereof after the Tables.

Tabula Distantiarum Horizontalium Projectionum.

Grad. Elev.	0	1	2	3	4	5	6	7	8	9	10	Dec. Min.
	0	6	12	18	24	30	36	42	48	54	60	
0	0	7	14	21	28	35	42	49	56	63	70	89
1	70	77	84	91	98	105	112	119	126	133	140	88
2	140	146	153	160	167	174	181	188	195	202	209	87
3	209	216	223	230	237	244	251	258	265	271	278	86
4	278	285	292	299	306	313	320	327	334	340	347	85
5	347	354	361	368	375	382	388	395	402	409	416	84
6	416	423	429	436	443	450	457	463	470	477	484	83
7	484	491	497	504	511	518	524	531	538	545	551	82
8	551	558	565	571	578	585	591	598	605	611	618	81
9	618	625	631	638	645	651	658	664	671	677	684	80
10	684	691	697	704	710	717	723	730	736	743	749	79
11	749	756	762	769	775	781	788	794	801	807	813	78
12	813	820	826	833	839	845	852	858	864	870	877	77
13	877	883	889	896	902	908	914	920	927	933	939	76
14	939	945	951	957	964	970	976	982	988	994	1000	75
15	1000	1006	1012	1018	1024	1030	1036	1042	1048	1054	1060	74
16	1060	1066	1072	1078	1083	1089	1095	1101	1107	1113	1118	73
17	1118	1124	1130	1136	1141	1147	1153	1159	1164	1170	1176	72
18	1176	1181	1187	1192	1198	1204	1209	1215	1220	1226	1231	71
19	1231	1237	1242	1248	1253	1259	1264	1269	1275	1280	1286	70
20	1286	1291	1296	1302	1307	1312	1317	1323	1328	1333	1338	69
21	1338	1343	1349	1354	1359	1364	1369	1374	1379	1384	1389	68
22	1389	1394	1399	1404	1409	1414	1419	1424	1429	1434	1439	67
23	1439	1444	1448	1453	1458	1463	1467	1472	1477	1482	1486	66
24	1486	1491	1496	1500	1505	1509	1514	1519	1523	1528	1532	65
25	1532	1537	1541	1545	1550	1554	1559	1563	1567	1572	1576	64
26	1576	1580	1585	1589	1593	1597	1601	1606	1610	1614	1618	63
27	1618	1622	1626	1630	1634	1638	1642	1646	1650	1654	1658	62
28	1658	1662	1666	1670	1674	1677	1681	1685	1689	1692	1696	61
29	1696	1700	1703	1707	1711	1714	1718	1721	1725	1729	1732	60
30	1732	1736	1739	1742	1746	1749	1753	1756	1759	1763	1766	59
31	1766	1769	1772	1776	1779	1782	1785	1788	1791	1795	1798	58
32	1798	1801	1804	1807	1810	1813	1816	1818	1821	1824	1827	57
33	1827	1830	1833	1836	1838	1841	1844	1846	1849	1852	1854	56
34	1854	1857	1860	1862	1865	1867	1870	1872	1875	1877	1879	55
35	1879	1882	1884	1886	1889	1891	1893	1896	1898	1900	1902	54
36	1902	1904	1906	1908	1911	1913	1915	1917	1919	1921	1923	53
37	1923	1924	1926	1928	1930	1932	1934	1935	1937	1939	1941	52
38	1941	1942	1944	1946	1947	1949	1950	1952	1953	1955	1956	51
39	1956	1958	1959	1961	1962	1963	1965	1966	1967	1968	1970	50
40	1970	1971	1972	1973	1974	1975	1976	1978	1979	1980	1981	49
41	1981	1981	1982	1983	1984	1985	1986	1987	1988	1988	1989	48
42	1989	1990	1990	1991	1992	1992	1993	1994	1994	1995	1995	47
43	1995	1996	1996	1996	1997	1997	1998	1998	1998	1999	1999	46
44	1999	1999	1999	1999	2000	2000	2000	2000	2000	2000	2000	45
Min.	60	54	48	42	36	30	24	18	12	6	0	Grad. Elev.
Dec.	10	9	8	7	6	5	4	3	2	1	0	

A Table of the Altitudes OF Projections above the Horizon.

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.									
	1	2	3	4	5	6	7	8	9	10
10	0	0	0	1	1	1	1	1	2	2
20	0	1	1	1	2	2	2	3	3	3
30	*0	1	1	2	2	3	3	4	5	5
40	0	1	2	2	3	4	4	5	6	7
50	0	1	2	3	4	5	5	6	7	8
60	0	1	2	3	4	5	6	8	9	10
70	0	*1	2	4	5	6	7	9	10	11
80		1	3	4	5	7	8	10	11	12
90		1	3	4	6	7	9	11	12	14
100		1	*3	5	6	8	10	12	13	15
110		1	3	5	7	8	10	12	14	16
120		1	3	5	7	9	11	13	15	17
130		0	3	5	7	9	12	14	16	19
140		0	2	*5	7	10	12	15	17	20
150			2	5	7	10	13	15	18	21
160			2	5	8	10	13	16	19	22
170			2	5	* 8	11	14	17	20	23
180			1	4	8	11	14	17	20	23
190			1	4	8	11	14	18	21	24
200			0	4	7	11	14	18	21	25
210				4	7	*11	15	18	22	26
220				3	7	11	15	19	22	26
230				3	7	11	15	19	23	27
240				2	6	11	15	19	23	28
250				2	6	10	*15	19	24	28
260				1	6	10	15	19	24	28
270				1	5	10	15	*19	24	29
280					5	10	14	19	24	29
290					4	9	14	19	24	30
300					4	9	14	19	24	30
310					3	8	14	19	*24	30
320					2	8	13	19	24	30
330					1	7	13	19	24	30
340					1	7	12	18	24	30
350						6	12	18	24	*30

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	10	11	12	13	14	15	16	17	18	19	20
10	2	2	2	2	2	3	3	3	3	3	4
20	3	4	4	5	5	5	6	6	6	7	7
30	5	6	6	7	7	8	8	9	9	10	11
40	7	7	8	9	10	10	11	12	13	13	14
50	8	9	10	11	12	13	14	15	16	17	17
60	10	11	12	13	14	15	16	17	19	20	21
70	11	12	14	15	16	17	19	20	21	23	24
80	12	14	15	17	18	20	21	23	24	26	27
90	14	15	17	19	20	22	24	25	27	29	30
100	15	17	19	20	22	24	26	28	30	32	34
110	16	18	20	22	24	26	28	30	32	34	37
120	17	20	22	24	26	28	31	33	35	37	40
130	19	21	23	26	28	30	33	35	38	40	43
140	20	22	25	27	30	32	35	37	40	43	45
150	21	23	26	29	31	34	37	40	43	45	48
160	22	24	27	30	33	36	39	42	45	48	51
170	23	26	29	32	35	38	41	44	47	50	54
180	23	27	30	33	36	40	43	46	50	53	56
190	24	28	31	34	38	41	45	48	52	55	59
200	25	28	32	36	39	43	47	50	54	58	61
210	26	29	33	37	41	44	48	52	56	60	64
220	26	30	34	38	42	46	50	54	58	62	66
230	27	31	35	39	43	47	52	56	60	64	69
240	28	32	36	40	45	49	53	58	62	67	71
250	28	32	37	41	46	50	55	59	64	69	73
260	28	33	38	42	47	52	56	61	66	71	75
270	29	34	38	43	48	53	58	63	68	73	78
280	29	34	39	44	49	54	59	64	69	74	80
290	30	35	40	45	50	55	60	66	71	76	82
300	30	35	40	46	51	56	62	67	73	78	84
310	30	35	41	46	52	57	63	69	74	80	86
320	30	36	41	47	53	58	64	70	76	82	87
330	30	36	42	48	53	59	65	71	77	83	89
340	30	36	42	48	54	60	66	72	79	85	91
350	*30	36	42	49	55	61	67	74	80	86	93

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.									
	20	21	22	23	24	25	26	27	28	29	30
10	4	4	4	4	4	5	5	5	5	6	6
20	7	8	8	8	9	9	10	10	11	11	11
30	11	11	12	12	13	14	14	15	16	16	17
40	14	15	16	17	17	18	19	20	21	22	23
50	17	18	19	20	22	23	24	25	26	27	28
60	21	22	23	24	26	27	28	29	31	32	33
70	24	25	27	28	30	31	33	34	36	37	39
80	27	29	30	32	34	35	37	39	40	42	44
90	30	32	34	36	38	40	41	43	45	47	49
100	34	36	37	39	42	44	46	48	50	52	54
110	37	39	41	43	45	48	50	52	55	57	59
120	40	42	44	47	49	52	54	57	59	62	64
130	43	45	48	50	53	55	58	61	64	67	69
140	45	48	51	54	56	59	62	65	68	71	74
150	48	51	54	57	60	63	66	69	73	76	79
160	51	54	57	60	64	67	70	73	77	80	84
170	54	57	60	64	67	70	74	78	81	85	89
180	56	60	63	67	70	74	78	82	85	89	93
190	59	63	66	70	74	78	81	85	89	94	98
200	61	65	69	73	77	81	85	89	94	98	102
210	64	68	72	76	80	85	89	93	98	102	107
220	66	71	75	79	83	88	92	97	101	106	111
230	69	73	78	82	87	91	96	101	105	110	115
240	71	76	80	85	90	94	99	104	109	114	119
250	73	78	83	88	93	98	103	108	113	118	124
260	75	80	85	90	96	101	106	111	117	122	128
270	78	83	88	93	98	104	109	115	120	126	132
280	80	85	90	96	101	107	112	118	124	130	136
290	82	87	93	98	104	110	115	121	127	133	139
300	84	89	95	101	107	112	118	125	131	137	143
310	86	91	97	103	109	115	121	128	134	140	147
320	87	93	100	106	112	118	124	131	137	144	151
330	89	95	102	108	114	121	127	134	141	147	154
340	91	97	104	110	117	123	130	137	144	151	158
350	93	99	106	112	119	126	133	140	147	154	161

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	30	31	32	33	34	35	36	37	38	39	40
10	6	6	6	6	7	7	7	7	8	8	8
20	11	12	12	13	13	14	14	15	15.	16	17
30	17	18	18	19	20	21	21	22	23	24	25
40	23	23	24	25	26	27	28	30	31	32	33
50	28	29	30	32	33	34	35	37	38	39	41
60	33	35	36	38	39	41	42	44	45	47	49
70	39	40	42	44	45	47	49	51	53	55	57
80	44	46	48	50	52	54	56	58	60	62	64
90	49	51	53	56	58	60	62	65	67	70	72
100	54	57	59	61	64	66	69	71	74	77	80
110	59	62	65	67	70	73	75	78	81	84	87
120	64	67	70	73	76	79	82	85	88	91	95
130	69	72	75	78	82	85	88	91	95	98	102
140	74	77	81	84	87	91	94	98	101	105	109
150	79	82	86	89	93	97	100	104	108	112	116
160	84	87	91	95	99	102	106	111	115	119	123
170	89	92	96	100	104	108	112	117	121	126	130
180	93	97	101	105	110	114	118	123	128	132	137
190	98	102	106	111	115	120	124	129	134	139	144
200	102	107	111	116	120	125	130	135	140	145	151
210	107	111	116	121	126	131	136	141	146	152	157
220	111	116	121	126	131	136	141	147	152	158	164
230	115	120	125	131	136	141	147	153	158	164	170
240	119	125	130	135	141	147	152	158	164	171	177
250	124	129	134	140	146	152	158	164	170	177	183
260	128	133	139	145	151	157	163	169	176	183	189
270	132	137	143	149	156	162	168	175	182	188	195
280	136	142	148	154	160	167	173	180	187	194	202
290	139	146	152	158	165	172	179	186	193	200	208
300	143	150	156	163	170	177	184	191	198	206	213
310	147	154	160	167	174	181	189	196	204	211	219
320	151	157	164	171	179	186	193	201	209	217	225
330	154	161	168	176	182	190	198	206	214	222	231
340	158	165	172	180	187	195	203	211	219	227	236
350	161	169	176	184	192	199	207	216	224	233	241

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	40	41	42	43	44	45	46	47	48	49	50
10	8	9	9	9	10	10	10	11	11	11	12
20	17	17	18	18	19	20	21	21	22	23	24
30	25	26	27	28	29	30	31	32	33	34	35
40	33	34	35	37	38	39	41	42	44	45	47
50	41	42	44	45	47	49	50	52	54	56	58
60	49	51	52	54	56	58	60	62	65	67	69
70	57	59	61	63	65	68	70	72	75	78	80
80	64	67	69	72	74	77	80	82	85	88	91
90	72	75	77	80	83	86	89	92	95	99	102
100	80	83	86	89	92	95	98	102	105	109	113
110	87	90	94	97	100	104	108	111	115	120	124
120	95	98	102	105	109	113	117	121	125	130	134
130	102	106	109	113	117	122	126	130	135	140	145
140	109	113	117	121	126	130	135	140	145	150	155
150	116	121	125	129	134	139	144	149	154	159	165
160	123	128	132	137	142	147	152	158	163	169	175
170	130	135	140	145	150	156	161	167	173	179	185
180	137	142	147	153	158	164	170	176	182	188	195
190	144	149	155	160	166	172	178	184	191	198	205
200	151	156	162	168	174	180	186	193	200	207	214
210	157	163	169	175	181	188	195	201	209	216	224
220	164	170	176	183	189	196	203	210	217	225	233
230	170	177	183	190	197	204	211	118	226	234	242
240	177	183	190	197	204	211	219	226	234	243	251
250	183	190	197	204	211	219	227	234	243	251	260
260	189	196	204	211	218	226	234	242	251	260	269
270	195	203	210	218	226	234	242	250	259	268	278
280	202	209	217	224	233	241	249	258	267	277	286
290	208	215	223	231	239	248	257	266	275	285	295
300	213	221	229	238	246	25[illegible]	264	273	283	293	303
310	219	227	236	244	253	262	271	281	291	301	311
320	225	233	242	251	260	269	278	288	298	309	319
330	231	239	248	257	266	276	285	295	306	31[illegible]	327
340	236	245	254	263	272	282	292	302	313	324	335
350	241	250	260	269	279	289	299	309	320	331	343

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	50	51	52	53	54	55	56	57	58	59	60
10	12	12	13	13	14	14	15	15	16	17	17
20	24	24	25	26	27	28	29	30	32	33	34
30	35	36	38	39	41	42	44	45	47	49	51
40	47	48	50	52	54	56	58	60	63	65	68
50	58	60	62	65	67	70	72	75	78	81	84
60	69	72	74	77	80	83	86	89	93	96	100
70	80	83	86	90	93	96	100	104	108	112	116
80	91	95	98	102	105	109	113	118	122	127	132
90	102	106	110	114	118	122	127	132	137	142	148
100	113	117	121	126	130	135	140	146	151	157	163
110	124	128	133	138	143	148	153	159	165	172	178
120	134	139	144	149	155	160	166	173	179	186	193
130	145	150	155	161	167	173	179	186	193	200	208
140	155	161	166	172	179	185	192	199	207	215	223
150	165	171	177	184	190	197	204	212	220	228	237
160	175	181	188	195	202	209	217	225	233	242	252
170	185	192	199	206	213	221	229	237	246	256	266
180	195	202	209	217	224	232	241	250	259	269	279
190	205	212	219	227	235	244	253	262	272	282	293
200	214	222	230	238	246	255	265	274	284	295	306
210	224	231	240	248	257	266	276	286	297	308	320
220	233	241	250	259	268	277	287	298	309	321	333
230	242	251	259	269	278	288	299	310	321	333	445
240	251	260	269	279	289	299	310	321	333	345	358
250	260	269	279	289	299	310	321	332	344	357	371
260	269	278	288	298	309	320	331	243	356	369	383
270	278	287	298	308	319	330	342	354	367	381	395
280	286	296	307	317	329	340	352	365	378	392	407
290	295	305	316	327	338	350	363	376	389	403	418
300	303	314	325	336	348	360	373	386	400	414	430
310	311	322	333	345	357	370	383	396	411	425	441
320	319	331	342	354	366	379	393	406	421	436	452
330	327	339	351	363	375	389	402	416	431	447	463
340	335	347	359	371	384	398	412	426	441	457	473
350	343	355	367	380	393	407	421	436	451	467	484

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	60	61	62	63	64	65	66	67	68	69	70
10	17	18	19	20	20	21	22	23	25	26	27
20	34	36	37	39	40	42	44	46	49	51	54
30	51	53	55	58	60	63	66	69	73	76	81
40	68	70	73	77	80	84	87	92	96	101	106
50	84	88	91	95	99	104	109	114	119	125	132
60	100	104	109	113	118	124	129	135	142	149	157
70	116	121	126	131	137	143	150	157	165	173	182
80	132	138	143	149	156	163	170	178	187	196	206
90	148	154	160	167	174	182	190	199	208	219	230
100	163	170	177	184	192	200	209	219	230	241	253
110	178	186	193	201	210	219	229	239	251	263	276
120	193	201	209	218	227	237	248	259	271	285	299
130	208	217	225	235	245	255	266	279	292	306	321
140	223	232	241	251	262	273	285	298	312	327	343
150	237	247	257	267	278	290	303	317	331	347	364
160	252	261	272	283	295	307	321	335	350	367	385
170	266	276	287	299	311	324	338	353	369	387	405
180	279	290	302	314	327	341	355	371	388	406	425
190	293	304	316	329	343	357	372	388	406	425	445
200	306	318	331	344	358	373	389	406	424	443	464
210	320	332	345	359	373	389	405	423	441	461	483
220	333	345	359	373	388	404	421	439	458	479	501
230	345	359	373	387	403	419	437	455	475	496	519
240	358	372	386	401	417	434	452	471	491	513	536
250	371	385	399	415	431	449	467	487	507	530	553
260	383	397	412	428	445	463	482	502	523	546	570
270	395	410	425	441	459	477	496	517	538	561	586
280	407	422	438	454	472	491	510	531	553	577	602
290	418	434	450	467	485	504	524	545	568	592	617
300	430	445	462	480	498	517	538	559	582	606	632
310	441	457	474	492	511	530	551	573	596	621	646
320	452	468	486	504	523	543	564	586	610	634	660
330	463	480	497	516	535	555	577	599	623	648	674
340	473	490	508	527	547	567	589	612	636	661	687
350	484	501	519	538	558	579	601	624	648	673	700

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distance	Degrees of Elevation.										
	70	71	72	73	74	75	76	77	78	79	80
10	27	29	31	32	35	37	40	43	46	51	56
20	54	57	61	64	68	73	79	85	92	100	110
30	81	85	90	95	102	109	116	125	136	148	163
40	106	112	119	126	134	143	154	165	179	195	214
50	132	139	147	156	166	177	190	204	221	240	263
60	157	166	175	186	197	210	225	242	261	284	310
70	182	192	203	215	228	243	260	279	301	326	356
80	206	217	229	243	258	275	294	315	339	368	401
90	230	242	256	271	287	306	326	350	377	407	443
100	253	267	282	298	316	336	358	384	413	446	484
110	276	291	307	324	344	365	389	417	448	483	524
120	299	315	332	350	371	394	420	449	481	518	561
130	321	338	356	376	398	422	449	480	514	553	597
140	343	360	380	401	424	449	478	510	545	586	631
150	364	383	403	425	449	476	506	539	576	617	664
160	385	404	425	448	474	502	532	567	605	647	695
170	405	426	448	472	498	527	558	594	633	676	725
180	425	446	469	494	521	551	584	620	659	704	752
190	445	467	490	516	544	574	608	645	685	730	778
200	464	486	511	537	566	597	631	669	710	754	803
210	483	506	531	558	587	619	654	692	733	778	825
220	501	525	550	578	608	640	676	714	755	799	846
230	519	543	569	598	628	661	697	735	776	820	866
240	536	561	588	617	647	681	717	755	796	839	884
250	553	579	606	635	666	700	736	774	815	857	900
260	570	596	623	653	684	718	754	792	832	873	914
270	586	612	640	670	702	736	772	809	849	888	927
280	602	628	656	687	718	752	788	825	864	902	938
290	617	644	672	703	735	768	804	841	878	914	947
300	632	659	688	618	750	784	819	855	891	925	955
310	646	674	702	733	765	798	833	868	903	935	961
320	660	688	717	747	779	812	846	880	913	943	966
330	674	702	731	761	793	825	858	891	923	950	969
340	687	715	744	774	805	837	870	902	931	955	970
350	700	728	756	787	818	849	881	911	938	959	*969

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation									
	80	81	82	83	84	85	86	87	88	89
10	56	62	70	80	93	111	138	18	266	491
20	110	122	137	156	181	215	265	345	491	817
30	163	180	202	229	265	313	383	490	674	*980
40	214	236	264	299	344	405	490	617	817	978
50	263	290	324	365	419	489	587	720	919	813
60	310	342	380	428	588	567	673	816	970	483
70	356	392	435	488	554	639	749	888	*959	0
80	401	440	487	544	615	704	815	942	977	
90	443	485	536	597	671	762	871	978	915	
100	484	529	582	646	723	814	916	995	811	
110	524	571	626	692	770	859	951	*995	666	
120	561	611	668	735	812	898	976	975	481	
130	597	648	707	774	850	930	*991	938	254	
140	631	684	743	810	884	955	*995	882	0	
150	664	717	777	843	912	974	989	809		
160	695	749	808	872	937	986	973	716		
170	725	778	837	898	956	992	946	606		
180	752	805	863	921	971	*991	909	477		
190	778	831	886	940	982	984	862	330		
200	803	854	907	956	988	970	805	165		
210	825	875	925	968	*989	949	737			
220	846	895	941	977	986	922	659			
230	866	912	954	983	978	888	571			
240	884	927	964	*985	966	848	473			
250	900	940	972	*984	949	801	364			
260	914	951	977	980	927	747	245			
270	927	960	*980	972	901	687	116			
280	938	967	*980	961	870	620				
290	947	972	978	946	835	547				
300	955	975	973	928	795	467				
310	961	*976	965	907	751	381				
320	966	974	955	883	702	287				
330	969	971	942	855	648	188				
340	970	966	927	823	590	82				
350	*969	958	909	789	527					

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.									
	6	7	8	9	10	11	12	13	14	15
350	6	12	18	24	30	36	42	49	55	61
360	5	11	18	24	30	36	43	49	55	62
370	4	11	17	24	30	*36	43	49	56	62
380	3	10	17	23	30	*36	43	50	56	63
390	3	9	16	23	30	36	43	50	57	64
400	2	8	15	22	29	36	*43	50	57	64
410	1	8	15	22	29	36	*43	50	58	65
420		7	14	21	29	36	43	51	58	65
430		6	13	21	28	36	43	51	58	66
440		5	12	20	28	35	43	*51	58	66
450		4	12	19	27	35	43	51	58	66
460		3	11	19	27	35	42	50	59	67
470		2	10	18	26	34	42	50	*59	67
480		0	9	17	25	34	42	50	58	67
490			8	16	25	33	41	50	58	67
500			7	15	24	32	41	50	58	*67
510			5	14	23	32	40	49	58	*67
520			4	13	22	31	40	49	58	67
530			3	12	21	30	39	48	58	67
540			2	11	20	29	39	48	57	67
550			0	10	19	28	38	47	57	66
560				8	18	27	37	47	56	66
570				7	17	27	36	46	56	66
580				6	16	25	35	45	55	65
590				4	14	24	34	45	55	65
600				3	13	23	33	44	54	64
610				1	12	22	32	43	53	64
620					10	21	31	42	53	63
630					9	19	30	41	52	62
640					7	18	29	40	51	62
650					6	17	28	39	50	61
660					4	15	26	38	49	60
670					2	14	25	36	48	59
680					1	12	24	35	47	58
690						11	22	34	46	57

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	15	16	17	18	19	20	21	22	23	24	25
350	61	67	74	80	86	93	99	106	112	119	126
360	62	68	75	81	88	94	101	108	115	121	128
370	62	69	76	82	89	96	103	110	117	124	131
380	63	70	77	84	90	97	104	112	119	126	133
390	64	71	78	85	92	99	106	113	121	128	136
400	64	71	79	86	93	100	108	115	123	130	138
410	65	72	79	87	94	102	109	117	124	132	140
420	65	73	80	88	95	103	111	118	126	134	142
430	66	73	81	89	96	104	112	120	128	136	144
440	66	74	82	89	97	105	113	121	130	138	146
450	66	74	82	90	98	106	115	123	131	140	148
460	67	75	83	91	99	108	116	124	133	141	150
470	67	75	83	92	100	109	117	126	134	143	152
480	67	75	84	92	101	109	118	127	136	145	154
490	67	76	84	93	102	110	119	128	137	146	155
500	*67	76	85	93	102	111	120	129	138	148	157
510	67	76	85	94	103	112	121	130	140	149	159
520	67	76	85	94	103	113	122	131	141	151	160
530	67	*76	85	95	104	113	123	132	142	152	162
540	67	76	85	95	104	114	124	133	143	153	163
550	66	76	85	95	105	115	124	134	144	154	164
560	66	76	*85	95	105	115	125	135	145	155	166
570	66	76	85	95	105	115	126	136	146	156	167
580	65	75	85	95	106	116	126	137	147	157	168
590	65	75	85	*95	106	116	127	137	148	158	169
600	64	75	85	95	106	116	127	138	148	159	170
610	64	74	85	95	106	117	127	138	149	160	171
620	63	74	84	95	*106	117	128	139	150	161	172
630	62	73	84	95	106	117	128	139	150	162	173
640	62	73	84	95	106	117	128	139	151	162	174
650	61	72	83	94	106	*117	128	140	151	163	175
660	60	71	83	94	105	117	128	140	152	163	175
670	59	71	82	94	105	117	*128	140	152	164	176
680	58	70	81	93	105	117	128	140	152	164	176
690	57	69	81	93	104	116	128	140	152	165	177

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	25	26	27	28	29	30	31	32	33	34	35
350	126	133	140	147	154	161	169	176	184	192	199
360	128	135	143	150	157	165	172	180	188	196	204
370	131	138	145	153	160	168	176	184	192	200	208
380	133	141	148	156	163	171	179	187	195	204	212
390	136	143	151	159	166	174	183	191	199	208	216
400	138	146	153	161	169	178	186	194	203	212	220
410	140	148	156	164	172	181	189	198	207	215	224
420	142	150	158	167	175	184	192	201	210	219	228
430	144	153	161	169	178	187	195	204	214	223	232
440	146	155	163	172	181	190	199	208	217	226	236
450	148	157	166	174	183	192	201	211	220	230	240
460	150	159	168	177	186	195	204	214	224	233	243
470	152	161	170	179	188	198	207	217	227	237	247
480	154	163	172	181	191	200	210	220	230	240	250
490	155	165	174	184	193	203	213	223	233	243	254
500	157	166	176	186	195	205	215	226	236	246	257
510	159	168	178	188	198	208	218	228	239	249	260
520	160	170	180	190	200	210	220	231	242	252	263
530	162	172	182	192	202	212	223	234	244	255	266
540	163	173	183	194	204	215	225	236	247	258	269
550	164	175	185	195	206	217	228	239	250	261	272
560	166	176	187	197	208	219	230	241	252	264	275
570	167	177	188	199	210	221	232	243	255	266	278
580	168	179	190	201	212	223	234	245	257	269	281
590	169	180	191	202	213	225	236	248	259	271	283
600	170	181	192	204	215	226	238	250	262	274	286
610	171	182	194	205	217	228	240	252	264	276	288
620	172	183	195	206	218	230	242	254	266	278	291
630	173	184	196	208	220	231	243	256	268	281	293
640	174	185	197	209	221	233	245	258	270	283	296
650	175	186	198	210	222	234	247	259	272	285	298
660	175	187	199	211	223	236	248	261	274	287	300
670	176	188	200	212	225	237	250	263	276	289	302
680	176	189	201	213	226	238	251	264	277	290	304
690	177	189	202	214	227	240	253	266	279	292	306

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	35	36	37	38	39	40	41	42	43	44	45
350	199	207	216	224	233	241	250	260	269	279	289
360	204	212	220	229	238	247	256	265	275	285	295
370	208	217	225	234	243	252	262	271	281	291	302
380	212	221	230	239	248	257	267	277	287	297	308
390	216	225	234	243	253	262	272	282	293	303	314
400	220	230	239	248	258	267	277	288	298	309	320
410	224	234	243	253	262	272	283	293	304	315	326
420	228	238	247	257	267	277	288	298	309	320	332
430	232	242	252	262	272	282	293	303	315	326	338
440	236	246	256	266	276	287	298	309	320	331	343
450	240	250	260	270	281	291	302	314	325	337	349
460	243	253	264	274	285	296	307	318	330	342	354
470	247	257	268	278	289	300	312	323	335	347	360
480	250	261	271	282	293	305	316	328	340	352	365
490	254	264	275	286	297	309	321	333	345	357	370
500	257	268	279	290	301	313	325	337	349	362	375
510	260	271	282	294	305	317	329	341	354	367	380
520	263	275	286	297	309	321	333	346	359	372	385
530	266	278	289	301	313	325	337	350	363	376	390
540	269	281	293	304	317	329	341	354	367	381	394
550	272	284	296	308	320	333	345	358	371	385	399
560	275	287	299	311	324	336	349	362	376	389	403
570	278	290	302	315	327	340	353	366	380	393	408
580	281	293	305	318	330	343	357	370	384	398	412
590	283	296	308	321	334	347	360	374	387	402	416
600	286	298	311	324	337	350	364	377	391	405	420
610	288	301	314	327	340	353	367	381	395	409	424
620	291	304	317	330	343	356	370	384	398	413	428
630	293	306	319	332	346	360	373	388	402	417	432
640	296	309	322	335	349	363	377	391	405	420	435
650	298	311	324	338	351	365	380	394	409	424	439
660	300	313	327	340	354	368	383	397	412	427	442
670	302	315	329	343	357	371	385	400	415	430	446
680	304	317	331	345	359	374	388	403	418	433	449
690	306	319	333	347	362	376	391	406	421	436	452

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	45	46	47	48	49	50	51	52	53	54	55
350	289	299	309	320	331	343	355	367	380	393	407
360	295	306	316	327	339	351	363	375	388	402	416
370	302	312	323	334	346	358	370	383	397	410	424
380	308	319	330	341	353	365	378	391	405	419	433
390	314	325	336	348	360	373	386	399	413	427	441
400	320	331	343	355	367	380	393	406	420	435	450
410	326	337	349	361	374	387	400	414	428	443	458
420	332	344	356	368	381	394	407	421	436	450	466
430	338	349	362	374	387	401	414	428	443	458	474
440	343	355	368	381	394	407	421	435	450	466	481
450	349	361	374	387	400	414	428	442	457	473	489
460	354	367	380	393	406	420	434	449	464	480	496
470	360	372	385	399	412	426	441	456	471	487	503
480	365	378	391	404	418	433	447	462	478	494	510
490	370	383	396	410	424	439	454	469	485	501	517
500	375	388	402	416	430	445	460	475	491	507	524
510	380	393	407	421	436	450	466	481	497	514	531
520	385	398	412	427	441	456	471	487	503	520	537
530	390	403	417	432	447	462	477	493	509	526	543
540	394	408	422	437	452	467	483	499	515	532	550
550	399	413	427	442	457	472	488	504	521	538	556
560	403	417	432	447	462	478	494	510	527	544	561
570	408	422	437	452	467	483	499	515	532	549	567
580	412	426	441	456	472	488	504	520	537	555	573
590	416	431	446	461	477	493	509	526	543	560	578
600	420	435	450	465	481	497	514	531	548	565	583
610	424	439	454	470	486	502	518	535	553	570	588
620	428	443	458	474	490	506	523	540	557	575	593
630	432	447	462	478	494	511	527	545	562	580	598
640	435	451	466	482	498	515	532	549	567	584	603
650	439	454	470	486	502	519	536	553	571	589	607
660	442	458	474	490	506	523	540	557	575	593	612
670	446	461	477	493	510	527	544	561	579	597	616
680	449	465	481	497	514	531	548	565	583	601	620
690	452	468	484	500	517	534	552	569	587	605	624

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	55	56	57	58	59	60	61	62	63	64	65
350	407	421	436	451	467	484	501	519	538	558	579
360	416	430	445	461	477	494	512	530	549	570	591
370	424	439	454	470	487	504	522	541	560	581	602
380	433	448	463	480	496	514	532	551	571	591	613
390	441	457	472	489	506	523	542	561	581	602	623
400	450	465	481	498	515	533	551	571	591	612	634
410	458	473	490	506	524	542	561	580	601	622	644
420	466	482	498	515	533	551	570	590	610	632	654
430	474	490	506	524	541	560	579	599	620	641	663
440	481	498	514	532	550	569	588	608	629	650	673
450	489	505	522	540	558	577	596	617	638	659	682
460	496	513	530	548	566	585	605	625	646	668	690
470	503	520	538	555	574	593	613	633	654	676	699
480	510	527	545	563	582	601	621	641	663	684	707
490	517	534	552	570	589	609	629	649	670	692	715
500	524	541	559	578	597	616	636	657	678	700	722
510	531	548	566	585	604	623	643	664	685	707	730
520	537	555	573	591	611	630	650	671	693	714	737
530	543	561	579	598	617	637	657	678	699	721	743
540	550	567	586	605	624	644	664	685	706	728	750
550	556	574	592	611	630	650	670	691	713	734	756
560	561	580	598	617	636	656	677	697	719	740	762
570	567	585	604	623	642	662	683	703	725	746	768
580	573	591	610	629	648	668	689	709	730	752	773
590	578	596	615	634	654	674	694	715	736	757	778
600	583	602	621	640	659	679	700	720	741	762	783
610	588	607	626	645	665	684	705	725	746	767	787
620	593	612	631	650	670	689	710	730	751	771	792
630	598	617	636	655	674	694	714	735	755	775	795
640	603	621	640	660	679	699	719	739	759	779	799
650	607	626	645	664	684	703	723	743	763	783	803
660	612	630	649	668	688	708	727	747	767	787	806
670	616	634	653	673	692	712	731	751	770	790	808
680	620	638	657	677	696	715	735	754	774	793	811
690	624	642	661	680	700	719	738	758	777	795	813

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	65	66	67	68	69	70	71	72	73	74	75
350	579	601	624	648	673	700	728	756	787	818	849
360	591	613	636	660	686	712	740	769	798	829	860
370	602	624	647	672	697	724	752	780	810	840	870
380	613	635	659	683	709	735	763	791	821	850	879
390	623	646	670	694	720	746	774	802	831	860	888
400	634	657	680	705	731	757	784	812	840	868	896
410	644	667	691	715	741	767	794	822	849	877	903
420	654	677	701	725	751	777	804	831	858	884	909
430	663	686	710	735	760	786	813	839	866	891	915
440	673	696	720	744	769	795	821	847	873	897	920
450	682	705	729	753	778	804	829	855	880	903	924
460	690	713	737	762	786	812	837	862	886	908	927
470	699	722	746	770	794	819	844	868	891	912	930
480	707	730	754	778	802	826	851	874	896	916	932
490	715	738	761	785	809	833	857	879	901	919	933
500	722	745	769	792	816	839	862	884	904	921	*933
510	730	752	776	799	822	845	868	889	907	923	933
520	737	759	782	805	828	851	872	892	910	924	932
530	743	766	789	811	834	856	877	896	912	*924	930
540	750	772	795	817	839	860	881	899	913	924	927
550	756	778	800	822	844	865	884	901	914	923	924
560	762	784	806	827	848	868	887	902	*915	921	920
570	768	789	811	832	852	872	889	904	914	919	915
580	773	794	816	836	856	875	891	904	913	916	909
590	778	799	820	840	855	877	892	*904	912	912	903
600	783	804	824	844	862	879	893	904	910	908	896
610	787	808	828	847	865	881	894	903	907	903	888
620	792	812	831	850	867	882	*894	902	904	897	879
630	795	815	834	852	869	883	894	900	900	891	870
640	799	818	837	854	870	*883	893	897	895	884	860
650	803	821	839	856	871	883	891	894	890	877	849
660	806	824	842	858	871	882	889	891	885	868	837
670	808	826	843	859	*872	881	887	887	879	859	825
680	811	829	845	859	871	880	884	882	872	850	812
690	813	830	846	*860	871	878	881	877	864	840	798

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	75	76	77	78	79	80	81	82	83	84	
350	849	881	911	938	959	969	958	909	789	527	
360	860	890	919	944	962	967	949	889	750	460	
370	870	899	926	949	963	963	938	866	709	388	
380	879	907	933	953	*963	958	924	840	664	311	
390	888	914	938	955	962	951	909	812	616	230	
400	896	921	942	957	959	942	891	781	565	145	
410	903	926	945	*957	955	932	871	748	510	55	
420	909	931	948	956	949	919	850	712	451		
430	915	935	949	954	943	906	826	673	390		
440	920	938	*949	950	934	890	800	632	325	—	—
450	924	940	949	946	925	873	772	588	256		
460	927	*941	947	940	914	854	743	542	185		
470	930	*941	944	934	901	834	711	493	110		
480	932	941	941	926	887	812	677	442	31		
490	933	940	936	917	872	788	641	388	—	—	—
500	*933	937	931	906	856	763	603	331			
510	933	934	924	895	838	736	563	272			
520	932	931	916	883	818	707	521	210			
530	930	926	908	869	798	677	477	146			
540	927	920	898	854	776	645	430	79	—	—	—
550	924	914	888	838	752	611	382	9			
560	920	906	876	821	728	576	332				
570	915	898	864	803	701	539	280				
580	909	889	850	783	674	500	225				
590	903	879	836	763	645	460	169	—	—	—	—
600	896	869	820	741	615	418	111				
610	888	857	804	718	583	374	50				
620	879	845	786	694	550	329					
630	870	831	768	668	516	282					
640	860	817	749	642	480	234	—	—	—	—	—
650	849	802	728	615	443	183					
660	837	786	707	586	404	132					
670	825	770	684	556	364	78					
680	812	752	661	525	323	23					
690	798	734	637	493	281						

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.									
	11	12	13	14	15	16	17	18	19	20
690	11	22	34	46	57	69	81	93	104	116
700	9	21	33	44	56	68	80	92	104	116
710	7	19	31	43	55	67	79	91	104	116
720	5	18	30	42	54	66	78	91	103	115
730	4	16	28	41	53	65	78	90	102	115
740	2	14	27	39	52	64	77	89	102	114
750		12	25	38	50	63	76	88	101	114
760		11	23	36	49	62	74	87	100	113
770		9	22	35	47	60	73	86	99	112
780		7	20	33	46	59	72	85	98	112
790		5	18	31	44	58	71	84	97	111
800		3	16	30	43	56	70	83	96	110
810		1	14	28	41	55	68	82	95	109
820			12	26	40	53	67	81	94	108
830			10	24	38	52	65	79	93	107
840			8	22	36	50	64	78	92	106
850			6	20	34	48	62	76	91	105
860			4	18	32	46	61	75	89	104
870			2	16	30	45	59	73	88	102
880				14	28	43	57	72	86	101
890				12	26	41	56	70	85	100
900				9	24	39	54	69	83	98
910				7	22	37	52	67	82	97
920				5	20	35	50	65	80	95
930				2	17	33	48	63	78	94
940					15	30	46	61	77	92
950					13	28	44	59	75	90
960					10	26	42	57	73	88
970					8	24	39	55	71	87
980					5	21	37	53	69	85
990					3	19	35	51	67	83
1000					0	16	32	49	65	81

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	20	21	22	23	24	25	26	27	28	29	30
690	116	128	*140	152	165	177	189	202	214	227	240
700	116	128	140	153	165	177	190	202	215	228	241
710	116	128	140	153	165	178	190	203	216	229	242
720	115	128	140	*153	165	178	191	204	217	230	243
730	115	127	140	153	165	178	191	204	217	230	244
740	114	127	140	153	165	178	191	205	218	231	245
750	114	127	139	152	*165	179	192	205	218	232	246
760	113	126	139	152	165	*179	192	205	219	233	246
770	112	126	139	152	165	179	192	206	219	233	247
780	112	125	138	152	165	179	192	206	220	234	248
790	111	124	138	151	165	178	*192	206	220	234	248
800	110	124	137	151	164	178	192	206	220	234	249
810	109	123	136	150	164	178	192	*206	220	235	249
820	108	122	136	150	164	178	192	206	220	235	249
830	107	121	135	149	163	177	192	206	*220	235	250
840	106	120	134	148	163	177	191	206	220	235	250
850	105	119	133	148	162	176	191	206	220	*235	250
860	104	118	132	147	161	176	191	205	220	235	250
870	102	117	131	146	161	175	190	205	220	235	*250
880	101	116	130	145	160	175	190	205	220	235	250
890	100	114	129	144	159	174	189	204	219	234	250
900	98	113	128	143	158	173	188	204	219	234	250
910	97	112	127	142	157	172	188	203	218	234	249
920	95	110	126	141	156	171	187	202	218	233	249
930	94	109	124	140	155	170	186	201	217	233	249
940	92	107	123	138	154	169	185	201	216	232	248
950	90	106	121	137	153	168	184	200	216	232	248
960	88	104	120	136	151	167	183	199	215	231	247
970	87	102	118	134	150	166	182	198	214	230	246
980	85	101	117	133	149	165	181	197	213	229	246
990	83	99	115	131	147	163	180	196	212	228	245
1000	81	97	113	129	146	162	178	195	211	227	244

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	30	31	32	33	34	35	36	37	38	39	40
690	240	253	266	279	292	306	319	333	347	362	376
700	241	254	267	280	294	308	321	335	350	364	379
710	242	255	268	282	296	309	323	337	352	366	381
720	243	256	270	283	297	311	325	339	354	368	383
730	244	257	271	285	299	313	327	341	356	371	386
740	245	258	272	286	300	314	328	343	358	373	388
750	246	259	273	287	301	316	330	345	360	374	390
760	246	260	274	288	303	317	332	346	361	376	392
770	247	261	275	289	304	318	333	348	363	378	394
780	248	262	276	290	305	319	334	349	364	380	395
790	248	262	277	291	306	321	336	351	366	381	397
800	249	263	277	292	307	322	337	352	367	383	399
810	249	263	278	293	308	323	338	353	369	384	400
820	249	264	279	294	309	324	339	354	370	386	402
830	250	264	279	294	309	325	340	355	371	387	403
840	250	265	280	295	310	325	341	356	372	388	404
850	250	265	280	295	311	326	342	357	373	389	405
860	250	265	280	296	311	327	342	358	374	390	407
870	*250	265	281	296	312	327	343	359	375	391	408
880	250	*265	281	296	312	328	344	360	376	392	408
890	250	265	281	296	312	328	344	360	376	393	409
900	250	265	*281	297	312	328	344	361	377	394	410
910	249	265	281	*297	313	329	345	361	378	394	411
920	249	265	281	297	*313	329	345	362	378	395	411
930	249	265	280	297	313	*329	345	362	378	395	412
940	248	264	280	296	313	329	*345	362	379	395	412
950	248	264	280	296	313	329	345	*362	379	396	413
960	247	263	280	296	312	329	345	362	*379	396	413
970	246	263	279	295	312	329	345	*362	379	396	413
980	246	262	279	295	312	328	345	362	*379	*396	413
990	245	261	278	295	311	328	345	362	379	396	*413
1000	244	261	277	294	311	328	345	362	379	396	413

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	40	41	42	43	44	45	46	47	48	49	50
690	376	391	406	421	436	452	468	484	500	51	534
700	379	393	408	424	435	455	471	487	504	521	538
710	381	396	411	426	442	458	474	490	507	524	541
720	383	398	414	429	445	461	477	493	510	527	544
730	386	401	416	432	447	464	480	496	513	530	548
740	388	403	418	434	450	466	483	499	516	533	551
750	390	405	421	436	453	469	485	502	519	536	553
760	392	407	423	439	455	471	488	505	522	539	556
770	394	409	425	441	457	474	490	507	524	541	559
780	395	411	427	443	459	476	493	509	527	544	561
790	397	413	429	445	461	478	495	512	529	546	564
800	399	415	431	447	463	480	497	514	531	549	566
810	400	416	432	449	465	482	499	516	533	551	568
820	402	418	434	450	467	484	501	518	535	553	570
830	403	419	435	452	469	486	503	520	537	555	572
840	404	421	437	454	470	487	504	522	539	556	574
850	405	422	438	455	472	485	506	523	541	558	576
860	407	423	440	456	473	490	507	525	542	560	577
870	408	424	441	458	474	482	509	526	544	561	579
880	408	425	442	459	476	493	510	527	545	563	580
890	409	426	443	460	477	494	511	529	546	564	581
900	410	427	444	461	478	495	512	530	547	565	582
910	411	428	445	462	479	496	513	531	548	566	583
920	411	428	445	462	480	497	514	532	549	567	584
930	412	429	446	463	480	498	515	532	550	567	585
940	412	429	446	464	481	498	516	533	551	568	586
950	413	430	447	464	481	499	516	534	551	569	586
960	413	430	447	464	482	499	517	534	552	569	586
970	413	430	447	465	482	500	517	534	552	569	587
980	413	430	448	465	482	500	517	535	552	570	587
990	*413	430	448	465	*483	500	517	535	552	570	*587
1000	413	*430	*448	*465	483	*500	*517	*535	*552	*570	587

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	50	51	52	53	54	55	56	57	58	59	60
690	534	552	569	587	605	624	642	661	680	700	719
700	538	555	573	591	609	627	646	665	684	703	722
710	541	559	576	594	612	631	650	668	687	707	726
720	544	562	580	598	616	634	653	672	691	710	729
730	548	565	583	601	619	638	656	675	694	713	731
740	551	568	586	604	622	641	659	678	697	715	734
750	553	571	589	607	625	644	662	681	699	718	737
760	556	574	592	610	628	646	665	683	702	720	739
770	559	577	595	613	631	649	668	686	704	723	741
780	561	579	597	615	633	652	670	688	707	725	743
790	564	582	600	618	636	654	672	691	709	727	744
800	566	584	602	620	638	656	674	693	710	728	746
810	568	586	604	622	640	658	676	694	712	730	747
820	570	588	606	624	642	660	678	696	714	731	748
830	572	590	608	626	644	662	680	697	715	732	749
840	574	592	610	628	646	663	681	699	716	733	749
850	576	594	611	629	647	665	683	700	717	734	750
860	577	595	613	631	649	666	684	701	718	734	750
870	579	597	614	632	650	667	685	702	718	735	*750
880	580	598	616	633	651	668	686	702	719	735	750
890	581	599	617	634	652	669	686	703	719	*735	749
900	582	600	618	635	653	670	687	703	* 719	734	749
910	583	601	619	636	653	670	667	703	719	734	748
920	584	602	619	637	654	671	687	*703	719	733	747
930	585	602	620	637	654	*671	687	703	718	733	746
940	586	603	620	638	654	671	687	703	718	732	745
950	586	603	621	638	*655	671	687	702	717	730	743
960	586	604	621	638	654	671	686	702	716	729	741
970	587	604	621	*638	654	670	686	701	715	728	739
980	587	*604	*621	638	654	670	685	700	713	726	737
990	*587	604	621	637	653	669	684	698	712	724	735
1000	587	604	620	637	653	668	683	697	710	722	732

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	60	61	62	63	64	65	66	67	68	69	70
690	719	738	758	777	795	813	830	846	*860	871	878
700	722	742	761	779	798	815	832	847	860	870	876
710	726	745	764	782	800	817	833	847	859	868	873
720	729	748	766	784	802	818	*834	*847	859	867	870
730	731	750	768	786	803	820	834	847	857	864	867
740	734	753	771	788	805	820	835	847	856	862	863
750	737	755	773	790	806	821	*834	846	854	859	858
760	739	757	774	791	807	821	834	845	852	855	854
770	741	758	776	792	807	*821	833	843	850	852	848
780	743	760	777	793	808	821	833	841	847	848	843
790	744	761	778	793	*808	821	831	839	843	843	837
800	746	763	779	794	808	820	830	837	840	838	830
810	747	763	779	*794	807	819	828	834	836	833	823
820	748	764	780	794	806	817	826	831	832	827	816
830	749	765	*780	793	806	816	823	827	827	821	808
840	749	765	779	793	804	814	820	823	822	815	800
850	750	*765	779	792	803	812	817	819	817	808	791
860	*750	765	779	791	801	809	814	815	811	801	782
870	750	764	778	789	799	806	810	810	805	793	773
880	750	764	777	788	797	803	806	805	798	785	763
890	749	763	775	786	794	800	802	800	792	777	752
900	749	762	774	784	792	796	797	794	785	768	742
910	748	761	772	782	788	792	792	788	777	759	730
920	747	759	770	779	785	788	787	781	769	749	719
930	746	758	768	776	782	784	782	775	761	739	707
940	745	756	766	773	778	779	776	768	752	729	694
950	743	754	763	770	774	774	770	760	744	718	681
960	741	752	760	766	769	769	764	752	734	707	668
970	739	749	757	762	765	763	757	744	725	695	654
980	737	746	754	758	760	757	750	736	715	683	640
990	735	744	750	754	755	751	742	727	704	671	625
1000	732	740	746	750	749	745	735	718	694	658	610

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.									
	70	71	72	73	74	75	76	77	78	79
690	878	881	877	864	840	798	734	637	493	281
700	876	877	872	857	829	784	714	611	459	237
710	873	873	865	848	817	768	694	585	425	191
720	870	868	859	839	805	752	673	558	389	144
730	867	863	852	829	792	736	652	529	352	96
740	863	858	844	819	779	718	629	500	314	47
750	858	851	836	808	765	700	605	470	275	
760	854	845	827	797	750	681	581	438	235	
770	848	838	818	785	734	661	556	406	194	
780	843	830	808	772	718	640	530	373	151	
790	837	822	797	759	701	619	503	339	107	
800	830	814	787	745	684	597	475	303	62	
810	823	805	775	731	666	574	446	267	16	
820	816	796	763	716	647	551	417	230		
830	808	786	751	700	628	527	386	192		
840	800	775	738	684	608	502	355	152		
850	791	764	725	667	587	476	323	112		
860	782	753	711	650	566	449	290	71		
870	773	741	696	632	544	422	256	29		
880	763	729	681	614	521	394	222			
890	752	716	665	594	497	365	186			
900	742	703	649	575	473	336	150			
910	730	690	633	555	449	306	113			
920	719	676	616	534	423	275	74			
930	707	661	598	512	397	243	36			
940	694	646	580	490	371	210				
950	681	630	561	468	343	177				
960	668	614	542	445	315	143				
970	654	598	522	421	287	109				
980	640	581	502	397	257	73				
990	625	563	481	372	228	37				
1000	610	546	460	346	197	0				

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.									
	16	17	18	19	20	21	22	23	24	25
1000	16	32	49	65	81	97	113	129	146	162
1010	14	30	46	63	79	95	111	128	144	160
1020	11	27	44	60	77	93	110	126	142	159
1030	8	25	41	58	75	91	108	124	141	157
1040	6	22	39	56	72	89	106	122	139	156
1050	3	20	36	53	70	87	104	120	137	154
1060	0	17	34	51	68	85	102	118	135	152
1070		14	31	48	65	82	99	116	133	150
1080		11	29	46	63	80	97	114	131	149
1090		8	26	43	60	78	95	112	129	147
1100		6	23	40	58	75	93	110	127	145
1110		3	20	38	55	73	90	108	125	143
1120			17	35	53	70	88	105	123	140
1130			14	32	50	68	85	103	121	138
1140			11	29	47	65	83	100	118	136
1150			8	26	44	62	80	98	116	134
1160			5	23	41	59	77	95	113	131
1170			2	20	38	56	75	93	111	129
1180				17	35	54	72	90	108	126
1190				14	32	51	69	87	106	124
1200				11	29	48	66	85	103	121
1210				7	26	45	63	82	100	119
1220				4	23	41	60	79	97	116
1230				0	19	38	57	76	94	113
1240					16	35	54	73	91	110
1250					13	32	51	70	88	107
1260					9	28	47	66	85	104
1270					6	25	44	63	82	101
1280					2	21	41	60	79	98
1290						18	37	57	76	95
1300						14	34	53	73	92
1310						11	30	50	69	89
1320						7	27	46	66	85
1330						3	23	43	62	82
1340							19	39	59	78

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	25	26	27	28	29	30	31	32	33	34	35
1000	162	178	195	211	227	244	261	277	294	311	328
1010	160	177	193	210	226	243	260	277	293	310	327
1020	159	176	192	209	225	242	259	276	293	310	327
1030	157	174	191	207	224	241	258	275	292	309	326
1040	156	173	189	206	223	240	257	274	291	308	325
1050	154	171	188	205	222	239	256	273	290	307	324
1060	152	169	186	203	220	237	255	272	289	306	324
1070	150	168	185	202	219	236	253	271	288	305	323
1080	149	166	183	200	217	235	252	269	287	304	322
1090	147	164	181	199	216	233	251	268	286	303	321
1100	145	162	179	197	214	232	249	267	284	302	319
1110	143	160	178	195	213	230	248	265	283	301	318
1120	140	158	176	193	211	228	246	264	281	299	317
1130	138	156	174	191	209	227	244	262	280	298	315
1140	136	154	172	189	207	225	243	261	278	296	314
1150	134	152	169	187	205	223	241	259	277	295	313
1160	131	149	167	185	203	221	239	257	275	293	311
1170	129	147	165	183	201	219	237	255	273	291	309
1180	126	145	163	181	199	217	235	253	271	289	307
1190	124	142	160	179	197	215	233	251	269	288	306
1200	121	140	158	176	195	213	231	249	767	286	304
1210	119	137	155	174	192	211	229	247	265	284	302
1220	116	134	153	171	190	208	227	245	263	282	300
1230	113	132	150	169	187	206	224	243	261	279	298
1240	110	129	148	166	185	203	222	240	259	277	295
1250	107	126	145	164	182	201	219	238	256	275	293
1260	104	123	142	161	180	198	217	235	254	272	291
1270	101	120	139	158	177	196	214	233	251	270	288
1280	98	117	136	155	174	193	212	230	249	267	286
1290	95	114	133	152	171	190	209	228	246	265	283
1300	92	111	130	149	168	187	206	225	244	262	281
1310	89	108	127	146	165	184	203	222	241	259	278
1320	85	105	124	143	162	181	200	219	238	257	275
1330	82	101	121	140	159	178	197	216	235	254	272
1340	78	98	117	137	156	175	194	213	232	251	269

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	35	36	37	38	39	40	41	42	43	44	45
1000	328	345	362	379	396	413	430	448	465	483	500
1010	327	344	361	378	396	413	430	448	465	482	500
1020	327	344	361	378	395	413	430	447	465	482	500
1030	326	343	360	378	395	412	430	447	465	482	500
1040	325	342	360	377	394	412	429	447	464	482	499
1050	324	342	359	376	394	411	429	446	464	481	499
1060	324	341	358	376	393	411	428	446	463	481	498
1070	323	340	358	375	393	410	428	445	463	480	498
1080	322	339	357	374	392	409	427	444	462	479	497
1090	321	338	356	373	391	408	426	444	461	479	496
1100	319	337	355	372	390	408	425	443	460	478	495
1110	318	336	354	371	389	406	424	442	459	477	494
1120	317	335	352	370	388	405	423	441	458	476	493
1130	315	333	351	369	386	404	422	439	457	474	492
1140	314	332	350	367	385	403	421	438	456	473	490
1150	313	330	348	366	384	402	419	437	454	472	489
1160	311	329	347	365	382	400	418	435	453	470	487
1170	309	327	345	363	381	399	416	434	451	468	486
1180	307	325	343	361	379	397	415	432	450	467	484
1190	306	324	342	360	377	395	413	430	448	465	482
1200	304	322	340	358	376	393	411	429	446	463	480
1210	302	320	338	356	374	392	409	427	444	461	478
1220	300	318	336	354	372	390	407	425	442	459	476
1230	298	316	334	352	370	388	405	423	440	457	474
1240	295	314	332	350	368	385	403	420	438	455	471
1250	293	311	330	348	365	383	401	418	435	452	469
1260	291	309	327	345	363	381	398	416	433	450	466
1270	288	307	325	343	361	379	396	413	430	447	464
1280	286	304	322	340	358	376	394	411	428	445	461
1290	283	302	320	338	356	373	391	408	425	442	458
1300	281	299	317	335	353	371	388	405	422	439	455
1310	278	296	315	333	350	368	386	403	419	436	452
1320	275	293	312	330	348	365	383	400	417	433	449
1330	272	291	309	327	345	362	380	397	413	430	446
1340	269	288	306	324	342	359	377	394	410	426	442

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	45	46	47	48	49	50	51	52	53	54	55
1000	500	517	535	552	570	587	604	620	637	653	668
1010	500	517	535	552	569	586	603	620	636	652	667
1020	500	517	535	552	569	586	603	619	635	651	666
1030	500	517	534	552	569	586	602	619	635	650	665
1040	499	517	534	551	568	585	602	618	634	649	663
1050	499	516	533	551	568	584	601	617	632	647	662
1060	498	516	533	550	567	583	600	616	631	646	660
1070	498	515	532	549	566	582	599	614	630	644	658
1080	497	514	531	548	565	581	597	613	628	642	656
1090	496	513	530	547	564	580	596	612	626	641	654
1100	495	512	529	546	563	579	595	610	625	638	651
1110	494	511	528	545	561	577	593	608	623	636	649
1120	493	510	527	543	560	576	591	606	620	634	646
1130	492	509	525	542	558	574	589	604	618	631	643
1140	490	507	524	540	557	572	587	602	616	629	641
1150	489	506	522	539	555	570	585	606	613	626	637
1160	487	504	521	537	553	568	583	597	611	623	634
1170	486	502	519	535	551	566	581	595	608	620	631
1180	484	501	517	533	549	564	578	592	605	617	627
1190	482	499	515	531	546	561	576	589	602	613	623
1200	480	497	513	529	544	559	573	586	598	610	620
1210	478	494	511	526	542	556	570	583	595	606	615
1220	476	492	508	524	539	553	567	580	592	602	611
1230	474	490	506	521	536	550	564	576	588	598	607
1240	471	487	503	519	533	547	561	573	584	594	602
1250	469	485	501	516	530	544	557	569	580	590	598
1260	466	482	498	513	527	541	554	566	576	585	593
1270	464	480	495	510	524	538	550	562	572	581	588
1280	461	477	492	507	521	534	546	558	568	576	583
1290	458	474	489	504	517	530	543	554	563	571	578
1300	455	471	486	500	514	527	539	549	559	566	572
1310	452	467	482	497	510	523	534	545	554	561	567
1320	449	464	479	493	506	519	530	540	549	556	561
1330	446	461	475	489	503	515	526	536	544	551	555
1340	442	457	472	486	499	510	521	531	539	545	549

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	55	56	57	58	59	60	61	62	63	64	65
1000	668	683	697	710	722	732	740	746	750	749	745
1010	667	682	696	708	720	729	737	742	745	744	738
1020	666	680	694	706	717	726	734	738	740	738	731
1030	665	679	692	704	714	723	730	734	735	732	724
1040	663	677	690	701	711	720	726	729	729	725	716
1050	662	675	688	699	708	716	722	724	723	719	709
1060	660	673	685	696	705	712	717	719	717	712	700
1070	658	671	683	693	702	708	713	714	711	704	692
1080	656	669	680	690	698	704	708	708	705	697	683
1090	654	666	677	687	694	700	703	702	698	689	674
1100	651	663	674	683	690	695	697	696	691	681	665
1110	649	661	671	679	686	690	692	690	684	673	656
1120	646	658	667	676	682	685	686	684	677	664	646
1130	643	654	664	672	677	680	680	677	669	656	636
1140	641	651	660	667	672	675	674	670	661	647	626
1150	637	648	656	663	668	669	668	663	653	637	615
1160	634	644	652	658	662	664	661	655	644	628	604
1170	631	640	648	654	657	658	655	648	636	618	593
1180	627	636	644	649	652	651	648	640	627	608	582
1190	623	632	639	644	646	645	641	632	618	598	570
1200	620	628	634	638	640	638	633	624	608	587	558
1210	615	623	629	633	634	632	626	615	599	576	546
1220	611	619	624	627	628	625	618	606	589	565	533
1230	607	614	619	622	621	618	610	597	579	554	520
1240	602	609	614	616	615	610	602	588	569	542	507
1250	598	604	608	609	608	603	593	579	558	530	494
1260	593	599	602	603	601	595	584	569	547	518	480
1270	588	593	596	597	594	587	576	559	536	506	466
1280	583	588	590	590	586	579	567	549	525	493	452
1290	578	582	584	583	579	570	557	539	513	480	437
1300	572	576	577	576	571	562	548	528	501	467	422
1310	567	570	571	569	563	553	538	517	489	453	407
1320	561	564	564	561	555	544	528	506	477	440	392
1330	555	558	557	554	546	535	518	495	465	426	376
1340	549	551	550	546	538	525	508	483	452	411	360

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	65	66	67	68	69	70	71	72	73	74	
1000	745	735	718	694	658	610	546	460	346	197	
1010	738	727	709	683	645	595	527	438	320	166	
1020	731	719	699	671	632	579	508	415	293	134	
1030	724	710	689	659	618	563	489	393	266	101	
1040	716	701	679	647	604	546	469	369	238	68	
1050	709	692	668	635	589	529	449	345	210	34	
1060	700	683	657	622	574	511	428	321	181		
1070	692	673	646	609	559	493	407	296	151		
1080	683	663	634	595	543	474	385	270	121		
1090	674	653	622	581	527	456	363	244	90		
1100	665	642	610	567	510	436	341	218	59		
1110	656	631	597	552	493	417	318	191	27		
1120	646	620	584	537	476	396	294	163			
1130	636	608	571	522	458	376	270	135			
1140	626	597	558	506	440	355	246	106			
1150	615	584	544	490	421	333	221	77			
1160	604	572	529	474	403	311	195	47			
1170	593	559	515	457	383	289	169	17			
1180	582	546	500	440	364	266	143				
1190	570	533	485	423	343	243	116				
1200	558	519	469	405	323	219	89				
1210	546	505	453	387	302	195	61				
1220	533	491	437	368	281	171	33				
1230	520	476	420	349	259	146	4				
1240	507	462	403	330	237	121					
1250	494	446	386	310	215	95					
1260	480	431	369	290	192	69					
1270	466	415	351	270	169	42					
1280	452	399	333	249	145	15					
1290	437	383	314	228	121						
1300	422	366	295	207	97						
1310	407	349	276	185	72						
1320	392	332	257	163	47						
1330	376	314	237	141	21						
1340	360	296	217	118							

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	22	23	24	25	26	27	28	29	30	31	
1340	19	39	59	78	98	117	137	156	175	194	
1350	15	35	55	75	94	114	133	153	172	191	
1360	12	32	51	71	91	111	130	149	169	188	
1370	8	28	48	68	87	107	127	146	165	185	
1380	4	24	44	64	84	103	123	143	162	181	—
1390		20	40	60	80	100	119	139	158	178	
1400		16	36	56	76	96	116	135	155	174	
1410		12	32	52	72	92	112	132	151	171	
1420		8	28	48	69	89	108	128	148	167	
1430	—	4	24	44	65	85	105	124	144	163	—
1440			20	40	61	81	101	121	140	160	
1450			16	36	57	77	97	117	136	156	
1460			11	32	52	73	93	113	132	152	
1470			7	28	48	69	89	109	128	148	
1480	—	—	3	23	44	64	85	105	124	144	—
1490				19	40	60	80	100	120	140	
1500				15	35	56	76	96	116	136	
1510				10	31	51	72	92	112	131	
1520				6	26	47	67	87	107	127	
1530	—	—	—	1	22	42	63	83	103	123	—
1540					17	38	58	79	99	118	
1550					12	33	54	74	94	114	
1560					8	29	49	69	89	109	
1570					3	24	44	65	85	105	
1580	—	—	—	—	—	19	40	60	80	100	—
1590						14	35	55	75	95	
1600						9	30	50	70	90	
1610						4	25	45	66	85	
1620							20	40	61	80	
1630	—	—	—	—	—	—	15	35	55	75	—
1640							10	30	50	70	
1650							4	25	45	65	
1660								20	40	60	
1670								14	35	54	

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.									
	31	32	33	34	35	36	37	38	39	40
1340	194	213	232	251	269	288	306	324	342	359
1350	191	210	229	248	266	285	303	321	339	356
1360	188	207	226	245	263	282	300	318	336	353
1370	185	204	223	241	260	278	297	315	332	350
1380	181	200	219	238	257	275	293	311	329	347
1390	178	197	216	235	253	272	290	308	326	343
1400	174	193	213	231	250	269	287	305	322	340
1410	171	190	209	228	247	265	283	301	319	336
1420	167	186	205	224	243	261	280	298	315	332
1430	163	183	202	221	239	258	276	294	312	329
1440	160	179	198	217	236	254	272	290	308	325
1450	156	175	194	213	232	250	269	286	304	321
1460	152	171	190	209	228	247	265	282	300	317
1470	148	167	187	206	224	243	261	279	296	313
1480	144	163	183	202	220	239	257	274	292	309
1490	140	159	179	197	216	235	253	270	288	304
1500	136	155	174	193	212	230	248	266	283	300
1510	131	151	170	189	208	226	244	262	279	296
1520	127	147	166	185	204	222	240	257	275	291
1530	123	142	162	181	199	217	235	253	270	287
1540	118	138	157	176	195	213	231	248	265	282
1550	114	133	153	172	190	208	226	244	261	277
1560	109	129	148	167	186	204	222	239	256	272
1570	105	124	143	162	181	199	217	234	251	267
1580	100	120	139	158	176	194	212	229	246	262
1590	95	115	134	153	171	190	207	224	241	257
1600	90	110	129	148	167	185	202	219	236	252
1610	85	105	124	143	162	180	197	214	231	247
1620	80	100	119	138	157	175	192	209	226	241
1630	75	95	114	133	151	169	187	204	220	236
1640	70	90	109	128	146	164	182	198	215	230
1650	65	85	104	123	141	159	176	193	209	225
1660	60	79	99	117	136	154	171	188	204	219
1670	54	74	93	112	130	148	165	182	198	213

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.										
	40	41	42	43	44	45	46	47	48	49	50
1340	359	377	394	410	426	442	457	472	486	499	510
1350	356	374	391	407	423	439	454	468	482	494	506
1360	353	370	387	404	420	435	450	464	478	490	502
1370	350	367	384	400	416	432	446	460	474	486	497
1380	347	364	380	397	413	428	442	456	469	481	492
1390	343	360	377	393	409	424	438	452	465	477	487
1400	340	357	373	389	405	420	434	448	460	472	483
1410	336	353	370	386	401	416	430	443	456	467	477
1420	332	349	366	382	397	412	426	439	451	462	472
1430	329	346	362	378	393	408	421	434	445	457	467
1440	325	342	358	374	389	403	417	430	441	452	461
1450	321	338	354	369	384	399	412	425	436	447	456
1460	317	334	350	365	380	394	408	420	431	441	450
1470	313	329	345	361	376	390	403	415	426	436	444
1480	309	325	341	356	371	385	398	410	421	430	438
1490	304	321	337	352	366	380	393	405	415	425	432
1500	300	316	332	347	361	375	388	399	410	419	426
1510	296	312	327	342	357	370	382	394	404	413	420
1520	291	307	323	338	352	365	377	388	398	407	414
1530	287	303	318	333	347	360	372	383	392	400	407
1540	282	298	313	328	341	354	366	377	386	394	400
1550	277	293	308	322	336	349	360	371	380	388	394
1560	272	288	303	317	331	343	355	365	374	381	387
1570	267	283	298	312	325	338	349	359	367	374	380
1580	262	278	293	307	320	332	343	353	361	368	372
1590	257	273	287	301	314	326	337	346	354	361	365
1600	252	267	282	295	308	320	331	340	348	354	358
1610	247	262	276	290	302	314	324	333	341	347	350
1620	241	256	271	284	296	308	318	327	334	339	343
1630	236	251	265	278	290	302	311	320	327	332	335
1640	230	245	259	272	284	295	305	313	320	324	327
1650	225	239	253	266	278	289	298	306	312	317	319
1660	219	234	247	260	272	282	291	299	305	309	311
1670	213	228	241	254	265	276	284	292	297	301	303

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.									
	50	51	52	53	54	55	56	57	58	59
1340	510	521	531	539	545	549	551	550	546	538
1350	506	517	526	534	539	543	544	543	538	529
1360	502	512	521	528	533	537	538	535	530	520
1370	497	507	516	522	528	530	531	528	522	511
1380	492	502	510	517	521	524	523	520	513	502
1390	487	497	505	511	515	517	516	512	504	492
1400	483	492	499	505	509	510	509	504	496	483
1410	477	486	493	499	502	503	501	496	487	473
1420	472	481	488	493	495	496	493	487	477	463
1430	467	475	482	486	489	488	485	479	468	453
1440	461	469	475	480	482	481	477	470	458	442
1450	456	463	469	473	474	473	469	461	449	432
1460	450	457	463	466	467	465	460	452	439	421
1470	444	451	456	459	460	457	452	442	429	410
1480	438	445	450	452	452	449	443	433	418	399
1490	432	439	443	445	444	441	434	423	408	387
1500	426	432	436	437	436	432	425	414	397	376
1510	420	425	429	430	428	424	416	404	387	364
1520	414	419	422	422	420	415	406	393	376	352
2530	407	412	414	415	412	406	397	383	364	340
1540	400	405	407	407	404	397	387	373	353	328
1550	394	398	399	399	395	388	377	362	342	315
1560	387	390	392	390	386	379	367	351	330	303
1570	380	383	384	382	377	369	357	340	318	290
1580	372	375	376	374	368	359	347	329	306	277
1590	365	368	368	365	359	350	336	318	294	264
1600	358	360	359	356	350	340	325	306	281	250
1610	350	352	351	347	340	330	315	295	269	237
1620	343	344	343	338	331	319	304	283	256	223
1630	335	336	334	329	321	309	292	271	243	209
1640	327	327	325	320	311	298	281	259	230	195
1650	319	319	316	310	301	288	270	246	217	180
1660	311	310	307	301	291	277	258	234	203	166
1670	303	302	298	291	280	266	246	221	190	151

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances	Degrees of Elevation.									
	59	60	61	62	63	64	65	66	67	68
1340	538	525	508	483	452	411	360	296	217	118
1350	529	516	497	472	439	397	344	278	196	95
1360	520	506	486	460	426	382	328	260	175	71
1370	511	496	475	448	412	367	311	241	154	47
1380	502	486	464	435	398	352	294	222	133	23
1390	492	475	453	423	384	336	276	202	111	
1400	483	465	441	410	370	321	259	183	89	
1410	473	454	429	397	356	305	241	163	66	
1420	463	443	417	383	341	288	223	142	43	
1430	453	432	405	370	326	272	204	122	20	
1440	442	421	392	356	311	255	186	101		
1450	432	409	380	342	296	238	167	80		
1460	421	397	367	328	280	220	147	58		
1470	410	385	354	314	264	203	128	36		
1480	399	373	340	299	248	185	108	14		
1490	387	361	327	284	231	167	88			
1500	376	348	313	269	215	148	67			
1510	364	335	299	254	198	130	47			
1520	352	322	285	238	181	111	26			
1530	340	309	270	222	163	92	4			
1540	328	296	256	206	146	72				
1550	315	282	241	190	128	52				
1560	303	268	226	174	110	33				
1570	290	254	211	157	91	12				
1580	277	240	195	140	73					
1590	264	226	179	123	54					
1600	250	211	164	105	35					
1610	237	197	147	88	16					
1620	223	182	131	70						
1630	209	166	115	52						
1640	195	151	98	34						
1650	180	135	81	15						
1660	166	120	64							
1670	151	104	46							

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.								
	29	30	31	32	33	34	35	36	37
1670	14	35	54	74	93	112	130	148	165
1680	9	29	49	69	88	107	125	143	160
1690	3	24	44	63	82	101	119	137	154
1700		18	38	58	77	95	114	131	148
1710		13	33	52	71	90	108	125	142
1720		7	27	46	65	84	102	120	137
1730		1	21	41	60	78	96	114	131
1740			15	35	54	72	90	108	124
1750			9	29	48	66	84	102	118
1760			4	23	42	60	78	96	112
1770				17	36	54	72	89	106
1780				11	30	48	66	83	99
1790				5	24	42	60	77	93
1800					17	36	53	70	86
1810					11	29	47	64	80
1820					5	23	40	57	73
1830						16	34	50	66
1840						10	27	44	60
1850						3	20	37	53
1860							13	30	46
1870							7	23	38
1880								16	31
1890								9	24
1900								2	17
1910									9
1920									2
1930									
1940									
1950									
1960									
1970									
1980									
1990									
2000									

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.								
	37	38	39	40	41	42	43	44	45
1670	165	182	198	213	228	241	254	265	276
1680	160	176	192	207	222	235	247	259	269
1690	154	171	186	201	216	229	241	252	262
1700	148	165	180	195	209	222	235	245	255
1710	142	159	174	189	203	216	228	239	248
1720	137	153	168	183	197	209	221	232	241
1730	131	147	162	177	190	203	214	225	234
1740	124	141	156	170	184	196	207	218	226
1750	118	134	149	164	177	189	201	210	219
1760	112	128	143	157	170	182	193	203	211
1770	106	122	136	151	164	176	186	196	204
1780	99	115	130	144	157	168	179	188	196
1790	93	109	123	137	150	161	172	181	188
1800	86	102	116	130	143	154	164	173	180
1810	80	95	110	123	135	147	157	165	172
1820	73	88	103	116	128	139	149	157	164
1830	66	81	96	109	121	132	141	149	156
1840	60	75	89	102	113	124	133	141	147
1850	53	67	81	94	106	116	125	133	139
1860	46	60	74	87	98	109	117	125	130
1870	38	53	67	79	91	101	109	116	122
1880	31	46	59	72	83	93	101	108	113
1890	24	38	52	64	75	85	93	99	104
1900	17	31	44	56	67	77	84	91	95
1910	9	24	37	49	59	68	76	82	86
1920	2	16	29	41	51	60	67	73	77
1930		8	21	33	43	52	59	64	68
1940		0	13	24	35	43	50	55	58
1950			5	16	26	34	41	46	49
1960				8	18	26	32	37	39
1970				0	9	17	23	27	30
1980					0	8	14	18	20
1990							5	8	10
2000									0

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.								
	45	46	47	48	49	50	51	52	53
1670	275	284	292	297	301	303	302	298	291
1680	269	277	285	290	293	294	293	289	281
1690	262	270	277	282	285	286	284	279	271
1700	255	263	270	274	277	277	275	270	261
1710	248	256	262	266	269	269	266	260	251
1720	241	248	254	258	260	260	257	250	240
1730	234	241	247	250	252	251	247	240	230
1740	226	233	239	242	243	242	238	230	219
1750	219	226	231	234	234	233	228	220	208
1760	211	218	222	225	225	223	218	210	197
1770	204	210	214	216	216	214	208	199	186
1780	196	202	206	208	207	204	198	186	175
1790	188	194	197	199	198	195	188	178	164
1800	180	185	189	190	189	185	178	167	152
1810	172	177	180	181	179	175	167	156	141
1820	164	169	171	172	170	165	157	145	129
1830	156	160	162	163	160	155	146	133	117
1840	147	151	153	153	150	144	135	122	105
1850	139	143	144	144	140	134	124	111	93
1860	130	134	135	134	130	123	113	99	80
1870	122	125	126	124	120	113	102	87	68
1880	113	116	116	114	110	102	91	75	55
1890	104	107	107	105	99	91	79	63	42
1900	95	97	97	94	89	80	68	51	30
1910	86	88	87	84	78	69	56	39	17
1920	77	78	78	74	68	58	44	26	3
1930	68	69	68	64	57	46	32	13	
1940	58	59	57	53	46	35	20	1	
1950	49	49	47	43	35	23	8		
1960	39	39	37	32	23	11			
1970	30	29	27	21	12	0			
1980	20	19	16	10	1				
1990	10	9	5						
2000	0								

A Table of the Altitudes of Projections above the Horizon.

Horizontal Distances.	Degrees of Elevation.								
	53	54	55	56	57	58	59	60	61
1670	291	280	266	246	221	190	151	104	46
1680	281	270	255	234	208	176	136	87	29
1690	271	259	243	222	195	162	121	71	11
1700	261	249	232	210	182	148	106	54	
1710	251	238	220	197	169	133	90	38	—
1720	240	227	208	185	155	119	74	21	
1730	230	215	196	172	142	104	59	4	
1740	219	204	184	159	128	89	42		
1750	208	193	172	146	114	74	26		
1760	197	181	160	133	100	59	10	—	—
1770	186	169	147	119	85	43			
1780	175	157	134	106	71	28			
1790	164	145	122	92	56	12			
1800	152	133	109	78	41				
1810	141	121	95	64	26	—	—	—	—
1820	129	108	82	50	11				
1830	117	95	69	36					
1840	105	83	55	21					
1850	93	70	41	6					
1860	80	57	27	—	—	—	—	—	—
1870	68	43	13						
1880	55	30							
1890	42	17							
1900	30	3							
1910	17	—	—	—	—	—	—	—	—
1920	3								
1930									
1940									
1950									
1960	—	—	—		—	—	—	—	—
1970									
1980									
1990									
2000									

Tables of the Horizontal Diſtances of Projections, in Deſcents below the Horizon.

Tables of the Horizontal-Distances of Projections, in Descents below the Horizon.

Descents.	Degrees from the Nadir.										
	1	2	3	4	5	6	7	8	9	10	11
100	2	3	5	7	9	10	12	14	15	17	19
200	3	7	10	13	17	20	23	27	30	34	37
300	5	10	15	20	25	29	34	39	44	49	54
400	6	13	19	26	32	38	45	51	58	64	71
500	8	16	24	31	39	47	55	63	71	79	87
600	9	18	28	37	46	56	65	74	84	93	103
700	11	21	32	42	53	64	74	85	96	107	118
800	12	24	36	48	60	72	84	96	108	120	132
900	13	26	40	53	66	79	93	106	119	133	146
1000	14	29	43	58	72	87	101	116	131	145	160

Descents.	Degrees from the Nadir.									
	11	12	13	14	15	16	17	18	19	20
100	19	21	23	24	26	28	30	32	34	35
200	37	40	44	47	51	55	58	62	65	69
300	54	59	65	70	75	80	85	91	96	101
400	71	78	84	91	98	104	111	118	125	132
500	87	95	103	111	120	128	136	145	153	162
600	103	112	122	131	141	151	160	170	180	190
700	118	128	139	150	161	173	184	195	206	218
800	132	144	157	169	181	194	206	219	232	245
900	146	160	173	187	201	215	228	242	256	271
1000	160	175	190	205	220	235	250	265	280	296

Descents.	Degrees from the Nadir.										
	20	21	22	23	24	25	26	27	28	29	30
100	35	37	39	41	43	45	47	49	52	54	56
200	69	73	77	80	84	88	92	96	100	104	109
300	101	107	112	118	123	129	135	141	147	153	159
400	132	139	146	153	161	168	176	183	191	198	206
500	162	170	179	188	197	206	215	224	233	242	252
600	190	200	211	221	231	242	252	263	274	285	296
700	218	229	241	253	265	277	289	301	313	326	338
800	245	258	271	284	297	310	324	337	351	365	379
900	271	285	299	314	328	343	358	373	388	403	418
1000	296	311	327	343	359	375	391	407	424	44[illegible]	45[illegible]

Horizontal Diſtances, in Deſcents below the Horizon.

Deſcents.	Degrees from the Nadir.										
	30	31	32	33	34	35	36	37	38	39	40
100	56	58	60	63	65	68	70	73	75	78	81
200	109	113	117	122	126	131	136	140	145	150	156
300	159	165	171	178	184	191	197	204	211	219	226
400	206	214	222	231	239	247	256	265	274	283	292
500	252	262	271	281	291	302	312	323	333	344	355
600	296	307	318	330	342	354	366	378	390	403	416
700	338	351	364	377	390	404	417	431	445	459	474
800	379	393	408	422	437	452	467	482	497	513	529
900	418	434	450	466	482	498	515	531	548	565	583
1000	457	474	491	508	526	543	561	579	597	616	635

Deſcents.	Degrees from the Nadir.									
	40	41	42	3	44	45	46	47	48	49
100	81	83	86	89	92	95	99	102	105	109
200	156	161	166	172	177	183	189	195	202	208
300	226	233	241	249	257	265	273	282	291	300
400	292	302	311	321	331	342	352	363	374	385
500	355	367	378	390	402	414	427	439	452	466
600	416	429	442	456	469	483	497	512	527	542
700	474	488	503	518	534	549	565	581	598	615
800	529	545	562	578	595	12	630	648	666	684
900	583	600	618	63	655	673	692	711	731	751
1000	635	654	673	692	712	732	752	773	794	815

Deſcents.	Degrees from the Nadir.									
	49	50	51	52	53	54	55	56	57	58
100	109	113	117	121	125	129	133	138	143	148
200	208	215	222	229	236	244	252	260	269	277
300	300	309	319	328	339	349	360	371	382	394
400	385	397	409	421	433	446	459	473	486	501
500	466	479	493	507	522	537	552	568	584	600
600	542	557	573	589	606	622	639	657	675	693
700	615	632	649	667	685	703	722	741	761	781
800	684	703	722	741	761	781	801	822	843	865
900	751	771	791	812	833	855	877	899	921	44
1000	815	836	858	880	903	926	949	973	996	21

Horizontal-Distances, in Descents below the Horizon.

Descents.	Degrees from the Nadir.								
	58	59	60	61	62	63	64	65	66
10	16	16	17	18	19	19	20	21	22
20	31	33	34	35	37	38	40	42	44
30	47	49	50	52	55	57	59	62	65
40	62	64	67	69	72	75	78	81	85
50	77	80	83	86	89	93	97	101	105
60	91	95	98	102	106	110	115	119	124
70	106	110	114	118	123	127	1 2	138	143
80	120	124	129	134	139	144	150	156	162
90	134	139	144	149	155	161	167	173	180
100	148	153	159	164	170	177	184	191	198
110	162	167	173	179	186	193	200	208	216
120	175	181	188	194	201	209	216	224	233
130	188	195	202	209	216	224	232	241	250
140	201	208	216	223	231	239	248	257	267
150	214	222	229	237	246	254	263	273	283
160	227	235	243	251	260	269	279	289	299
170	240	248	256	265	274	284	294	304	315
180	253	261	270	279	288	298	309	319	331
190	265	274	283	292	302	313	323	334	346
200	277	286	296	306	316	327	338	349	361
210	289	299	309	319	329	340	352	364	376
220	301	311	321	332	343	354	366	378	391
230	313	324	334	345	356	368	380	393	406
240	325	336	346	358	369	381	394	407	420
250	337	348	359	370	382	394	407	421	434
260	349	360	371	383	395	408	421	434	449
270	360	371	383	395	408	421	434	448	463
280	371	383	395	407	420	433	447	461	476
290	383	395	407	419	432	446	460	475	490
300	394	406	418	431	445	459	473	488	503
400	501	515	530	546	562	578	595	613	631
500	600	617	634	652	670	688	708	727	747
600	693	712	731	750	770	791	812	833	855
700	781	801	822	843	865	887	910	933	957
800	865	886	909	932	955	978	1003	1027	1052
900	944	968	991	1016	1040	1065	1091	1116	1143
1000	1021	1045	1070	1096	1122	1148	1175	1202	1229

Horizontal-Distances, in Descents below the Horizon.

Descents.	Degrees from the Nadir.								
	66	67	68	69	70	71	72	73	74
10	22	23	24	26	27	28	30	32	34
20	44	46	48	50	53	56	59	62	66
30	65	68	71	74	78	82	86	91	96
40	85	89	93	97	102	107	112	118	125
50	105	109	114	120	125	131	138	145	152
60	124	130	135	141	148	155	162	170	179
70	143	149	156	163	170	178	186	195	205
80	162	169	176	183	191	200	209	219	229
90	180	188	195	204	212	222	231	242	253
100	198	206	214	223	233	243	253	265	277
110	216	224	233	243	253	263	274	286	299
120	233	242	251	262	272	283	295	308	321
130	250	259	269	280	291	303	315	329	342
140	267	277	287	298	310	322	335	349	364
150	283	293	305	316	328	341	355	369	384
160	299	310	322	334	346	360	374	388	404
170	315	326	338	351	364	378	392	408	424
180	331	343	355	368	381	396	411	426	443
190	346	358	371	384	398	413	429	445	462
200	361	374	387	401	415	430	446	463	480
210	376	389	403	417	432	447	464	480	498
220	391	405	418	433	448	464	481	498	516
230	406	420	434	449	464	480	497	515	534
240	420	434	449	464	480	497	514	532	551
250	434	449	464	479	496	513	530	549	568
260	449	463	479	495	511	528	546	565	584
270	463	478	493	509	526	544	562	581	601
280	476	492	508	524	541	559	578	597	617
290	490	506	522	539	556	574	593	613	633
300	503	519	536	553	571	589	608	628	649
400	631	649	668	688	709	729	751	773	796
500	747	768	789	811	833	856	880	904	929
600	855	878	901	924	949	973	999	1024	1051
700	957	981	1005	1030	1056	1082	1109	1136	1164
800	1052	1078	1104	1130	1157	1184	1212	1241	1269
900	1143	1170	1197	1224	1252	1281	1310	1339	1369
1000	1229	1257	1286	1314	1343	1373	1403	1433	1464

Horizontal-Diſtances, in Deſcents below the Horizon.

Deſcents.	Degrees from the Nadir.								
	74	75	76	77	78	79	80	81	82
10	34	36	39	41	45	48	53	58	64
20	66	70	74	79	85	92	99	108	117
30	96	102	108	115	123	131	141	152	164
40	125	132	140	148	158	168	180	193	207
50	152	161	170	180	191	203	216	230	246
60	179	188	199	210	222	235	249	265	282
70	205	215	226	238	252	266	281	298	316
80	229	241	253	266	280	295	312	329	349
90	253	265	278	292	307	323	341	359	379
100	277	289	303	318	334	351	369	388	409
110	299	313	327	343	359	377	395	415	437
120	321	335	350	367	384	402	421	442	464
130	342	357	373	390	408	426	446	467	490
140	364	379	395	412	431	450	470	492	515
150	384	400	417	434	453	473	494	516	539
160	404	420	438	456	475	496	517	539	563
170	424	440	458	477	497	517	539	562	586
180	443	460	478	497	518	539	561	584	609
190	462	479	498	518	538	560	582	606	631
200	480	498	517	537	558	580	603	627	652
210	498	517	536	556	578	600	623	648	673
220	516	535	555	575	597	620	643	668	693
230	534	553	573	594	616	639	663	687	713
240	551	570	591	612	634	658	682	707	733
250	568	588	608	630	653	676	700	726	752
260	584	605	626	648	671	694	719	745	771
270	601	621	643	665	688	712	737	763	790
280	617	638	660	682	706	730	755	781	808
290	633	654	676	699	723	747	772	799	826
300	649	670	692	716	739	764	790	816	844
400	796	820	845	870	896	922	950	978	1007
500	929	955	981	1008	1035	1063	1092	1122	1152
600	1051	1078	1105	1133	1162	1192	1222	1252	1283
700	1164	1192	1221	1250	1280	1310	1341	1372	1404
800	1269	1299	1329	1359	1390	1421	1453	1485	1517
900	1369	1400	1430	1462	1493	1525	1558	1590	1623
1000	1464	1496	1527	1559	1592	1624	1657	1690	1724

Horizontal-Distances, in Descents below the Horizon.

Descents.	Degrees from the Nadir.								
	82	83	84	85	86	87	88	89	90
10	64	71	80	91	104	121	142	168	200
20	117	129	142	157	175	197	221	250	283
30	164	178	194	213	233	257	283	313	346
40	207	223	241	261	283	308	336	367	400
50	246	264	283	305	328	354	383	414	447
60	282	301	322	344	369	396	425	456	490
70	316	336	358	381	407	433	464	495	529
80	349	369	392	416	442	470	500	532	566
90	379	401	424	449	475	504	534	566	600
100	409	431	455	480	507	536	566	598	632
110	437	459	484	510	537	566	597	629	663
120	464	487	512	538	566	595	626	659	693
130	490	514	539	565	594	623	654	687	721
140	515	539	565	592	620	650	681	714	748
150	539	564	590	617	646	676	708	740	775
160	563	588	614	642	671	701	733	766	800
170	586	612	638	666	695	726	757	790	825
180	609	634	661	689	719	749	781	814	849
190	631	657	684	712	742	772	804	837	872
200	652	678	706	734	764	795	827	860	894
210	673	699	727	756	786	817	849	882	917
220	693	720	748	777	807	838	870	904	938
230	713	740	768	798	828	859	891	925	959
240	733	760	788	818	848	879	912	945	980
250	752	780	808	838	868	900	932	966	1000
260	771	799	827	857	888	919	952	985	1020
270	790	818	846	876	907	939	971	1005	1039
280	808	836	865	895	926	957	990	1024	1058
290	826	854	883	913	944	976	1009	1043	1077
300	844	872	901	931	962	994	1027	1061	1095
400	1007	1037	1067	1098	1130	1163	1196	1230	1265
500	1152	1182	1214	1246	1278	1312	1345	1380	1414
600	1283	1315	1347	1379	1413	1446	1480	1514	1549
700	1404	1436	1469	1502	1536	1570	1604	1638	1673
800	1517	1550	1583	1617	1651	1685	1719	1754	1789
900	1623	1657	1690	1724	1759	1793	1828	1862	1897
1000	1724	1758	1792	1826	1861	1895	1930	1965	2000

Horizontal Diſtances in Deſcents below the Horizon.

Deſcents.	Degrees from the Nadir.								
	82	83	84	85	86	87	88	89	90
1	7	8	9	11	14	18	24	37	63
2	14	16	18	22	26	33	44	61	89
3	21	23	27	31	38	47	60	80	110
4	27	31	35	41	49	59	75	96	126
5	34	38	43	50	59	71	88	111	141
6	40	45	51	59	69	82	100	124	155
7	46	52	58	67	78	93	111	136	167
8	52	58	66	75	87	102	122	147	179
9	58	65	73	83	96	112	132	158	190
10	64	71	80	91	104	121	142	168	200

Deſcents.	Degrees of Elevation.								
	0	1	2	3	4	5	6	7	8
0	0	70	140	209	278	347	416	484	551
1	63	107	164	227	292	358	425	492	558
2	89	131	183	242	304	369	434	500	565
3	110	150	200	256	316	379	443	507	572
4	126	166	214	268	327	388	451	514	578
5	141	181	227	280	337	397	459	522	585
6	155	194	240	291	347	406	467	529	591
7	167	206	251	302	357	414	474	535	597
8	179	217	262	312	365	422	482	542	603
9	190	228	272	321	374	430	489	549	609
10	200	238	281	330	382	438	496	555	615

Degr. Elev.										
0	Deſcent. 1	.2	.3	.4	.5	Deſcent. 6	.7	.8	.9	1.0
	Ho. Diſt. 20.0	28.3	34.6	40.0	44.7	Ho. Diſt. 49.0	52.9	56.4	60.0	63.2

&c.

Horizontal Distances in Descents below the Horizon.

Descents.	Degrees of Elevation.								
	0	1	2	3	4	5	6	7	8
0	0	70	140	209	278	347	416	484	551
10	200	238	281	330	382	438	496	555	615
20	283	320	361	406	454	505	558	613	669
30	346	383	423	466	512	560	610	662	716
40	400	436	476	517	602	608	657	707	758
50	447	483	522	563	606	652	699	747	797
60	490	526	564	605	647	692	738	785	834
70	529	565	603	643	685	729	774	820	868
80	566	602	639	679	720	763	808	853	900
90	600	636	673	713	754	796	840	885	931
100	632	668	706	745	785	827	870	915	960
110	663	699	736	775	815	857	900	943	988
120	693	728	766	804	844	885	928	971	1015
130	721	757	794	832	872	913	955	997	1041
140	748	784	821	859	899	939	981	1023	1066
150	775	810	847	885	924	965	1006	1048	1091
160	800	836	872	910	949	989	1030	1072	1114
170	825	860	897	935	973	1013	1054	1095	1137
180	849	884	921	958	997	1037	1077	1118	1160
190	872	907	944	981	1020	1059	1099	1140	1182
200	894	930	966	1004	1042	1081	1121	1162	1203
210	917	952	988	1026	1064	1103	1143	1183	1224
220	938	973	1010	1047	1085	1124	1164	1204	1245
230	959	995	1031	1068	1106	1145	1184	1224	1265
240	980	1015	1051	1089	1126	1165	1204	1244	1284
250	1000	1035	1072	1109	1146	1185	1224	1264	1304
260	1020	1055	1091	1128	1166	1204	1243	1283	1322
270	1039	1075	1111	1148	1185	1223	1262	1301	1341
280	1058	1094	1130	1167	1204	1242	1281	1320	1359
290	1077	1112	1148	1185	1223	1261	1299	1338	1377
300	1095	1131	1167	1203	1241	1279	1317	1356	1395
400	1265	1300	1336	1372	1409	1446	1483	1520	1558
500	1414	1449	1485	1521	1557	1593	1630	1666	1703
600	1549	1584	1620	1655	1691	1727	1763	1798	1834
700	1673	1708	1744	1779	1814	1850	1885	1920	1955
800	1789	1824	1859	1894	1929	1964	1999	2034	2068
900	1897	1932	1967	2002	2037	2072	2106	2141	2175
1000	2000	2035	2070	2105	2139	2174	2208	2242	2275

Horizontal-Distances in Descents below the Horizon.

Descents.	Degrees of Elevation.								
	8	9	10	11	12	13	14	15	16
0	551	618	684	749	813	877	939	1000	1060
10	615	676	737	798	858	918	977	1036	1094
20	669	726	783	841	899	956	1013	1070	1125
30	716	770	825	881	936	992	1047	1102	1156
40	758	811	864	917	971	1025	1079	1132	1185
50	797	848	900	952	1004	1056	1109	1161	1212
60	834	883	933	984	1035	1086	1138	1188	1239
70	868	916	965	1015	1065	1115	1165	1215	1264
80	900	948	996	1045	1094	1143	1192	1241	1289
90	931	977	1025	1073	1121	1169	1217	1265	1313
100	960	1006	1053	1100	1147	1195	1242	1289	1336
110	988	1033	1079	1126	1173	1219	1266	1313	1359
120	1015	1060	1105	1151	1197	1243	1289	1335	1381
130	1041	1085	1130	1176	1221	1267	1312	1357	1402
140	1066	1110	1154	1199	1244	1289	1334	1379	1423
150	1091	1134	1178	1222	1267	1311	1356	1400	1444
160	1114	1157	1201	1245	1289	1333	1377	1420	1464
170	1137	1180	1223	1267	1310	1354	1397	1440	1483
180	1160	1202	1245	1288	1331	1374	1417	1460	1503
190	1182	1224	1266	1309	1352	1394	1437	1479	1521
200	1203	1245	1287	1329	1372	1414	1456	1498	1540
210	1224	1266	1307	1349	1391	1433	1475	1517	1558
220	1245	1286	1327	1369	1411	1452	1494	1535	1576
230	1265	1305	1347	1388	1429	1471	1512	1553	1593
240	1284	1325	1366	1407	1448	1489	1530	1570	1611
250	1304	1344	1385	1425	1466	1507	1547	1588	1628
260	1322	1363	1403	1444	1484	1524	1565	1605	1644
270	1341	1381	1421	1461	1502	1542	1582	1621	1661
280	1359	1399	1439	1479	1519	1559	1599	1638	1677
290	1377	1417	1456	1496	1536	1576	1615	1654	1693
300	1395	1434	1474	1513	1553	1592	1631	1670	1709
400	1558	1596	1634	1672	1709	1747	1784	1820	1856
500	1703	1740	1776	1813	1849	1884	1920	1955	1989
600	1834	1870	1906	1941	1976	2010	2044	2078	2111
700	1955	1990	2025	2060	2093	2127	2160	2192	2223
800	2068	2103	2137	2170	2203	2236	2268	2299	2329
900	2175	2208	2242	2275	2307	2338	2369	2400	2429
1000	2275	2308	2341	2373	2405	2436	2466	2496	2524

Horizontal-Distances in Descents below the Horizon.

Descents.	Degrees of Elevation.								
	16	17	18	19	20	21	22	23	24
0	1060	1118	1176	1231	1286	1338	1389	1439	1486
10	1094	1150	1206	1260	1312	1364	1414	1462	1508
20	1125	1180	1234	1287	1338	1388	1437	1484	1530
30	1156	1209	1262	1313	1363	1412	1460	1506	1551
40	1185	1237	1288	1338	1387	1435	1482	1527	1571
50	1212	1263	1313	1363	1411	1458	1504	1548	1591
60	1239	1289	1338	1386	1433	1480	1525	1568	1611
70	1264	1313	1362	1409	1455	1501	1545	1588	1630
80	1289	1337	1385	1431	1477	1522	1565	1607	1648
90	1313	1360	1407	1453	1498	1542	1585	1626	1667
100	1336	1383	1429	1474	1518	1562	1604	1645	1684
110	1359	1405	1450	1495	1538	1581	1622	1663	1702
120	1381	1426	1471	1515	1558	1600	1641	1681	1719
130	1402	1447	1491	1534	1577	1618	1659	1698	1736
140	1423	1467	1511	1554	1596	1637	1676	1715	1753
150	1444	1487	1530	1572	1614	1654	1694	1732	1769
160	1464	1507	1549	1591	1632	1672	1711	1749	1785
170	1483	1526	1568	1609	1650	1689	1728	1765	1801
180	1503	1545	1586	1627	1667	1706	1744	1781	1817
190	1521	1563	1604	1644	1684	1723	1760	1797	1832
200	1540	1581	1622	1662	1701	1739	1776	1813	1848
210	1558	1599	1639	1679	1717	1755	1792	1828	1863
220	1576	1616	1656	1695	1734	1771	1808	1843	1877
230	1593	1633	1673	1712	1750	1787	1823	1858	1892
240	1611	1659	1690	1728	1766	1802	1838	1873	1907
250	1628	1667	1706	1744	1781	1818	1853	1888	1921
260	1644	1683	1722	1760	1797	1833	1868	1902	1935
270	1661	1700	1738	1775	1812	1848	1883	1916	1949
280	1677	1715	1753	1791	1827	1862	1897	1930	1963
290	1693	1731	1769	1806	1842	1877	1911	1944	1976
300	1709	1747	1784	1821	1856	1891	1925	1958	1990
400	1856	1892	1927	1961	1994	2026	2058	2088	2117
500	1989	2023	2056	2088	2119	2149	2179	2207	2234
600	2111	2143	2174	2205	2234	2263	2290	2317	2342
700	2223	2254	2284	2313	2342	2369	2395	2419	2443
800	2329	2359	2388	2416	2442	2468	2493	2516	2538
900	2429	2458	2486	2512	2538	2563	2586	2608	2629
1000	2552	2552	2579	2604	2629	2653	2675	2696	2716

Horizontal-Distances in Descents below the Horizon.

Descents.	Degrees of Elevation.								
	24	25	26	27	28	29	30	31	32
0	1486	1532	1576	1618	1658	1696	1732	1766	1798
10	1508	1553	1596	1637	1677	1714	1749	1782	1813
20	1530	1574	1616	1656	1695	1731	1766	1799	1829
30	1551	1594	1635	1675	1713	1749	1783	1814	1844
40	1571	1614	1654	1693	1730	1765	1799	1830	1859
50	1591	1633	1673	1711	1747	1782	1815	1846	1874
60	1611	1651	1691	1728	1764	1798	1830	1861	1889
70	1630	1670	1708	1745	1781	1814	1846	1876	1903
80	1648	1688	1726	1762	1797	1830	1861	1890	1918
90	1667	1705	1743	1779	1813	1845	1876	1905	1932
100	1684	1723	1760	1795	1829	1861	1891	1919	1945
110	1702	1740	1776	1811	1844	1876	1905	1933	1959
120	1719	1757	1792	1827	1859	1890	1920	1947	1973
130	1736	1773	1808	1842	1874	1905	1934	1961	1986
140	1753	1789	1824	1857	1889	1919	1948	1974	1999
150	1769	1805	1840	1872	1904	1933	1961	1988	2012
160	1785	1821	1855	1887	1918	1947	1975	2001	2025
170	1801	1836	1870	1902	1932	1961	1989	2014	2038
180	1817	1852	1885	1916	1946	1975	2002	2027	2050
190	1832	1867	1899	1931	1960	1988	2015	2040	2063
200	1848	1881	1914	1945	1974	2002	2028	2052	2075
210	1863	1896	1928	1959	1987	2015	2041	2065	2087
220	1877	1910	1942	1972	2001	2028	2053	2077	2099
230	1892	1925	1956	1986	2014	2041	2066	2089	2111
240	1907	1939	1970	1999	2027	2054	2078	2102	2123
250	1921	1953	1983	2013	2040	2066	2091	2114	2135
260	1935	1966	1997	2026	2053	2079	2103	2125	2146
270	1949	1980	2010	2039	2066	2091	2115	2137	2158
280	1963	1994	2023	2051	2078	2103	2127	2149	2169
290	1976	2007	2036	2064	2091	2116	2139	2160	2180
300	1990	2020	2049	2077	2103	2128	2151	2172	2191
400	2117	2145	2171	2196	2220	2242	2262	2281	2298
500	2234	2259	2284	2306	2328	2348	2366	2383	2398
600	2342	2365	2388	2409	2428	2447	2463	2478	2491
700	2443	2465	2486	2505	2523	2540	2554	2567	2579
800	2538	2559	2579	2596	2613	2628	2641	2652	2662
900	2629	2649	2667	2683	2698	2712	2723	2734	2742
1000	2716	2734	2751	2766	2780	2792	2803	2811	2818

Horizontal-Diſtances in Deſcents below the Horizon.

Deſcents.	Degrees of Elevation.								
	32	33	34	35	36	37	38	39	40
0	1798	1827	1854	1879	1902	1923	1941	1956	1970
100	1945	1970	1992	2013	2031	2047	2061	2073	2082
200	2075	2096	2114	2131	2146	2159	2170	2178	2185
300	2191	2209	2225	2239	2251	2261	2269	2275	2279
400	2298	2314	2327	2338	2348	2356	2361	2365	2366
500	2398	2411	2422	2431	2439	2444	2448	2449	2449
600	2491	2502	2511	2519	2524	2528	2530	2529	2527
700	2579	2588	2596	2602	2605	2607	2607	2605	2601
800	2662	2670	2676	2680	2683	2683	2682	2678	2672
900	2742	2748	2753	2756	2757	2756	2753	2748	2740
1000	2818	2824	2827	2828	2828	2825	2821	2815	2806

Deſcents.	Degrees of Elevation.								
	40	41	42	43	44	45	46	47	48
0	1970	1981	1989	1995	1999	2000	1999	1995	1989
100	2082	2090	2095	2097	2097	2095	2091	2084	2075
200	2185	2189	2191	2191	2188	2183	2176	2167	2155
300	2279	2280	2280	2277	2272	2265	2256	2244	2230
400	2366	2366	2363	2358	2351	2342	2330	2316	2300
500	2449	2446	2441	2435	2425	2414	2401	2385	2367
600	2527	2522	2516	2507	2496	2483	2468	2451	2431
700	2601	2595	2587	2576	2564	2549	2532	2513	2492
800	2672	2665	2655	2643	2629	2612	2594	2573	2551
900	2740	2731	2720	2707	2691	2673	2653	2631	2607
1000	2806	2796	2783	2768	2751	2732	2711	2687	2662

Deſcents.	Degrees of Elevation.								
	48	49	50	51	52	53	54	55	56
0	1989	1981	1970	1956	1942	1923	1902	1879	1854
100	2075	2064	2050	2034	2016	1995	1972	1947	1920
200	2155	2141	2125	2107	2086	2063	2038	2010	1981
300	2230	2214	2195	2175	2152	2127	2100	2070	2038
400	2300	2282	2262	2239	2214	2187	2158	2127	2093
500	2367	2347	2325	2301	2274	2245	2214	2181	2146
600	2431	2409	2385	2359	2331	2300	2268	2233	2196
700	2492	2469	2443	2415	2385	2353	2319	2283	2244
800	2551	2526	2499	2469	2438	2405	2369	2331	2291
900	2607	2581	2552	2522	2489	2454	2417	2378	2336
1000	2662	2634	2604	2572	2538	2502	2463	2423	2380

Horizontal Diſtances in Deſcents below the Horizon.

Deſcents.	Degrees of Elevation.								
	56	57	58	59	60	61	62	63	64
0	1854	1827	1798	1766	1732	1696	1658	1618	1576
100	1920	1890	1858	1824	1788	1750	1710	1667	1623
200	1981	1949	1915	1879	1841	1801	1758	1714	1668
300	2038	2005	1969	1931	1891	1849	1805	1759	1711
400	2093	2058	2020	1980	1938	1895	1849	1801	1752
500	2146	2108	2069	2028	1984	1939	1891	1842	1791
600	2196	2157	2116	2073	2028	1981	1932	1881	1828
700	2244	2204	2161	2117	2070	2022	1971	1919	1865
800	2291	2249	2205	2159	2111	2061	2009	1955	1900
900	2336	2293	2247	2200	2151	2099	2046	1991	1934
1000	2380	2335	2288	2240	2189	2136	2082	2025	1967

Deſcents.	Degrees of Elevation.								
	64	65	66	67	68	69	70	71	72
0	1576	1532	1486	1439	1389	1338	1286	1231	1176
100	1623	1577	1530	1480	1429	1376	1321	1265	1207
200	1668	1620	1571	1519	1466	1411	1355	1297	1237
300	1711	1661	1610	1556	1501	1445	1387	1327	1266
400	1752	1700	1647	1592	1536	1477	1418	1356	1294
500	1791	1738	1683	1626	1568	1509	1447	1384	1320
600	1828	1774	1717	1659	1600	1539	1476	1412	1346
700	1865	1809	1751	1691	1630	1568	1503	1438	1371
800	1900	1842	1783	1722	1660	1596	1530	1463	1395
900	1934	1875	1815	1752	1689	1623	1556	1488	1418
1000	1967	1907	1845	1781	1716	1650	1581	1512	1441

Deſcents.	Degrees of Elevation.								
	72	73	74	75	76	77	78	79	80
0	1176	1118	1060	1000	939	877	813	749	684
100	1207	1148	1088	1026	963	899	834	768	701
200	1237	1177	1114	1051	986	921	854	786	718
300	1266	1204	1140	1075	1009	941	873	804	733
400	1294	1230	1164	1098	1030	961	891	820	748
500	1320	1255	1188	1120	1050	980	909	836	763
600	1346	1279	1210	1141	1070	998	926	852	777
700	1371	1302	1232	1161	1089	1016	942	867	791
800	1395	1325	1254	1181	1108	1033	958	881	804
900	1418	1347	1274	1201	1126	1050	973	896	817
1000	1441	1368	1295	1220	1144	1067	988	909	829

Horizontal Distances in Descents below the Horizon.

Descents.	Degrees of Elevation.									
	80	81	82	83	84	85	86	87	88	89
0	684	618	551	484	416	347	278	209	140	70
100	702	633	565	496	426	358	285	214	143	72
200	718	648	578	507	436	364	292	219	146	73
300	733	662	591	518	445	372	298	224	149	75
400	748	676	603	529	454	379	304	228	152	76
500	763	689	614	539	463	387	310	233	155	78
600	777	702	626	549	471	394	315	237	158	79
700	791	714	636	558	480	400	321	241	161	80
800	804	726	647	568	488	407	326	245	163	82
900	817	737	657	577	495	413	331	249	166	83
1000	829	749	667	585	503	420	336	252	168	84

Of the Use of the Tables of Projection, for making of a Shot at Demand.

1. Of the Table of Horizontal Distances.

THe Horizontal Projection of a Peece at the Elevation of 15, or 75 degrees (equal to the greatest Projection in Altitude) being 1000. parts, and the double thereof the Greatest Randon, or Horizontal Projection at the Elevation of 45 degrees, *viz.* 2000 parts, as in the Table, I would make a shot at the Horizontal Distance of 1550. of the same parts, and to this, the true Elevation of my Peece is required.

Therefore, In the Table, seeking 1550, or the neareſt number to it; and finding 1550, I see right against it, in the farthest column on the left hand, 25 Degrees, and right over the said 1550, on the top, 4 Decimals, or 24 minutes.

Also, against the same 1550, I see in the farthest column on the right hand 64 Degrees, and under 1550, in the bottom, 6 Decimals, or 36 minutes.

So I conclude, that to ſtrike the ſaid Horizontal Diſtance of 1550 parts, the true Elevation of the Chaſe of my Peece, muſt be either 25 Degrees 4 tenths, or 64 Degrees 6 tenths, &c.

But ſuppoſe the Greateſt Randon of a Peece 6400 Paces, of which the half is 3200, the Randon at 15 or 75 Degrees of Elevation: and I would make a ſhot at the Horizontal Diſtance of 5712 Paces.

I ſay firſt, as 3200, is to 1000; So is 5712, to 1785.

Then to 1785 parts, I find the Elevation (in the Table as afore) either 31 Degrees 6 tenths, or 58 Degrees 4 tenths, &c.

2. Of the Uſe of the Table of Altitudes.

Example 1.

With a Cannon-Royal, whoſe Greateſt Randon is found 3298 Paces, I would make a Shot at a place Horizontally Diſtant 2012 Paces, and in Altitude higher than the Peece 282 Paces.

And firſt, to reduce theſe numbers unto thoſe of the Table, I ſay, as half the Greateſt Randon 1649, is to 1000; ſo is 2012, to 1220.

And again, As 1649, is to 1000; ſo is 282, to 171.

Then in the Table, finding the Horizontal Diſtance 1220 on the left hand, I ſeek right againſt it for the Altitude 171; And I find it firſt under 28 Degrees, and again further forward under 70 Degrees; either of which at pleaſure, is the true Elevation of the Peece for making of the Shot propoſed.

Example 2.

With a Baſilisk, whoſe Greateſt Randon is 11233 Paces, I would ſtrike a place Horizontally Diſtant 10250 Paces, and in Altitude 375 Paces.

Therefore I ſay, As 11233, is to 2000; So is 10250, to 1825, the Tabular Horizontal Diſtance.

Alſo, As 11333, is to 2000; ſo is 375, to 67 *fere*, the Tabular Altitude.

And in the Table, with the ſaid Diſtance 1825, and Altitude 67, by making proportion as need requires, I find the Leſſer Elevation of the Peece for ſtriking the aforeſaid place, 36 Degrees 8 tenths, and the Greater Elevation 55 Degrees 3 tenths.

3. Of the Uſe of the Table of Horizontal Diſtances, together with that of Altitudes.

SUppoſe that to the Greateſt Randon 2000, the Horizontal Diſtance reduced is 245, and the Altitude reduced 19, to which the Greater Elevation of the Peece is required.

In the Table of Altitudes, I find that the ſaid Elevation is between 86 and 87 Degrees; for to the reduced Horizontal Diſtance 245, the anſwerable Altitude under 86 Degrees is 419, but under 87 Degrees there is none.

Therefore, in the aforegoing Table of Horizontal Diſtances, to the ſaid reduced Diſtance 245, I find the Greater Elevation 86 Degrees 29 minutes.

Then I ſay, if the Altitude 419, diminiſheth 29 minutes; then the reduced Altitude 19, ſhall diminiſh 1 minute, which accordingly taken from 86 Degrees 29 minutes, there remaineth 86 Degrees 28 minutes, the true Elevation ſought.

4. Of

4. Of the Use of the Tables of Horizontal Distances in Descents.

Example I.

WIth a Basilisk, whose Greatest Randon is given as afore 11233 Paces, I would strike a place which is Horizontally Distant 12637 Paces, and in Descent lower than the Peece 1809 Paces.

I say, As 11233, is to 2000, so is { 12637, to 2250 / 1809, to —322

Then in the Tables, to the Descent 322, and Horizontal Distance 2250, by making proportion of the differences between the neareſt leſſer and greater numbers, I find the leſſer Elevation of the Peece 34 degrees 2 tenths, and the greater 47 degrees 7 tenths.

Example II.

WIth a Culverin, whose Greatest Randon is proved 4837 Paces, to strike a Place Horizontally Distant 363 Paces, and in Descent 48 Paces.

As 4837, is to 2000; So is { 363, to 150. / --48, to --20.

Then in the former part of the Tables, the Descent 20, and Horizontal Distance 150, gives 84 Degrees 5 tenths, from the Nadir, the Complement of which is 5 Degrees 5 tenths, the Depression of the Peece: Also in the latter part of the Tables the said Descent 20, and Distance 150, gives 87 Degrees and 9 tenths *fere*, the Elevation.

And these Examples I suppose may well suffice touching the Use of the aforesaid Tables, which are as applicable unto any other Gunnes, Morter-Peeces, or Bombards; as also unto Bowes, Instruments for the Projection of Water, and all other the like Engines.

A2

A Table of the Diameters of Iron Spheres.

Weight. Pounds.	Diameter. Inch. Cent.	Weight. Pounds.	Diameter. Inch. Cent.	Weight. Pounds.	Diameter. Inch. Cent.
0½	1.53	31	6.04	66	7.77
0¾	1.75	32	6.11	67	7.81
1	1.92	33	6.17	68	7.85
1¼	2.20	34	6.23	69	7.89
2	2.42	35	6.29	70	7.93
2½	2.61	36	6.35	71	7.96
3	2.77	37	6.41	72	8.00
3½	2.92	38	6.47	73	8.04
4	3.05	39	6.52	74	8.07
5	3.29	40	6.58	75	8.11
6	3.49	41	6.63	76	8.15
7	3.68	42	6.68	77	8.18
8	3.85	43	6.74	78	8.22
9	4.00	44	6.79	79	8.25
10	4.14	45	6.84	80	8.29
11	4.28	46	6.89	81	8.32
12	4.40	47	6.94	82	8.35
13	4.52	48	6.99	83	8.39
14	4.63	49	7.04	84	8.42
15	4.74	50	7.08	85	8.46
16	4.85	51	7.13	86	8.49
17	4.94	52	7.18	87	8.52
18	5.04	53	7.22	88	8.55
19	5.13	54	7.27	89	8.59
20	5.22	55	7.31	90	8.62
21	5.31	56	7.36	91	8.65
22	5.39	57	7.40	92	8.68
23	5.47	58	7.44	93	8.71
24	5.55	59	7.49	94	8.74
25	5.62	60	7.53	95	8.77
26	5.70	61	7.57	96	8.81
27	5.77	62	7.61	97	8.84
28	5.84	63	7.65	98	8.87
29	5.91	64	7.69	99	8.90
30	5.98	65	7.73	100	8.93

A Table of the Solidities of Spheres.

Parts.

Diameter	1	2	3	4	5	6
Dec. 0	0.52	4.19	14.14	33.51	65.45	113.10
1	0.76	4.85	15.60	36.09	69.46	118.85
2	0,90	5.58	17.16	38.79	73.62	124.79
3	1.15	6.37	18.82	41.63	77.95	130.92
4	1.44	7.24	20.58	44.60	82.45	137.26
5	1.77	8.18	22.45	47.71	87.11	143.79
6	2.14	9.20	24.43	50.96	91.95	150.53
7	2.57	10.31	26.52	54.36	96.97	157.48
8	3.05	11.49	28.73	57.91	102.16	164.64
9	3.59	12.77	31.06	61.60	107.54	172.01
10	4.19	14.14	33.51	65.45	113.10	179.59

Parts.

Diameter	7	8	9	10	11	12
Dec. 0	179.6	268.1	381.7	523.6	696.9	904.8
1	187.4	278.3	394.6	539,5	716.1	927.6
2	195.4	288.7	407.7	555.6	735.6	950.8
3	203.7	299.4	421.2	572.2	755.5	974.3
4	212.2	310.3	434.9	589.0	775.7	998.3
5	220.9	321.6	448.9	606.1	796.3	1022.7
6	229.8	333.0	463.2	623.6	817.3	1047.4
7	239.0	344.8	477.9	641.4	838.6	1072.5
8	248.5	356.8	492.8	659.6	860.3	1098.1
9	258.2	369.1	508.0	678.1	882.3	1124.0
10	268.1	381.7	523.6	696.9	904.8	1150.4

Parts.

Diameter	13	14	15	16	17	18
Dec. 0	1150.4	1436.8	1767.1	2144.7	2572.4	3053.6
1	1177.1	1467.8	1802.7	2185.1	2618.1	3104.8
2	1204.3	1499.2	1838.8	2226.1	2664.3	3156.5
3	1231.8	1531.1	1875.3	2267.6	2711.0	3208.9
4	1259.8	1563.5	1912.3	2309.6	2758.3	3261.8
5	1288.2	1596.3	1949.8	2352.1	2806.2	3315.2
6	1317.1	1629.5	1987.8	2395.1	2854.5	3369.3
7	1346.4	1663.2	2026.3	2438.6	2903.5	3423.9
8	1376.1	1697.4	2065.2	2482.7	2953.0	3479.1
9	1406.2	1732.0	2104.7	2527.3	3003.0	3535.0
10	1436.8	1767.1	2144.7	2572.4	3053.6	3591.4

Of the Uſe of the two laſt Tables.

THat of the *Diameters of Iron Spheres*, is plain enough of it ſelf: by which, making proportion for the intermediate differences, the Diameter may be readily found by the Weight of any Spherical ſolid Iron Shot, from half a pound to 100 pounds; and contrarily, the Weight by the Diameter.

By that of the *Solidities of Spheres*, the Diameter of the Spherical concavity of any Granado, being given; the quantity of Pouder requiſit for the filling of it, may be ſpeedily obtained; As in theſe *Examples*.

1. Suppoſe the Diameter of ſuch a concavity, 6 inches and and 5 tenths: Then, under 6 on the top, and againſt 5 Dec. on the left hand of the Table, you have the ſolidity or content, 143.79. that is, 143 Cubical inches, and 79 centeſmes.

2. Again; Suppoſing the Diameter 8 Inches and 65 Centeſmes, the ſolidity, by making proportion of the difference between 333.0, and 344.8, will be found 338.9, that is 338 Inches and 9 tenths.

Contrarily, in the ſame Table; by the given Solidity, you may eaſily find the Diameter; And both as well in feet, or any other parts, as inches.

And here note; that it hath been often tryed and found, that 4 ounces of Pouder moderately ſhaked together, will fill a Cube whoſe ſide is 2 inches, or the whole Cube 8 inches.

Therefore, if you divide the given Solidity in inches, by 32, the Quotient will be pounds, and the remainer half ounces.

So in the laſt Example, dividing the 338 inches and 9 tenths there found, by 32; you ſhall find the weight in Pouder, 10 Pounds, 9 Ounces, and 45 Centeſmes.

FINIS.